AN INDUSTRY PERSPECTIVE ON FAA R&D PROGRAMS

HEARING

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTH CONGRESS

FIRST SESSION

DECEMBER 7, 1995

[No. 38]

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AN INDUSTRY PERSPECTIVE ON FAA R&D PROGRAMS

THURSDAY, DECEMBER 7, 1995

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
SUBCOMMITTEE ON TECHNOLOGY,
Washington, DC.

The Subcommittee met at 9:30 a.m., in Room 2318 of the Rayburn House Office Building, the Honorable Constance A. Morella, Chairwoman of the Subcommittee, presiding.

Mrs. MORELLA. I'm going to call the hearing of the Subcommittee on Technology to order.

As I mentioned, we have Democrats who are at the White House on the budget and Republicans who are at a conference.

But I am here and you are here and the record will be intact and there will be opportunities for follow-up after today and people will be joining us.

Today, the Technology Subcommittee begins the second in a series of hearings that we've been holding on the research and development programs of the Federal Aviation Administration.

We held our first meeting in May of this year. And in the second session of this Congress, we will continue on this subject, with the intention of crafting an FAA research and development authorization bill to be introduced early next year.

Over the past decade, major FAA modernization projects have experienced significant cost, schedule and performance problems.

For example, although the FAA began efforts to update the air traffic control system in 1981, limited progress has been made, despite 14 years of efforts and the expenditure of several billions of taxpayer dollars.

In our May hearing, we received testimony indicating that the major issues affecting FAA are not the budgeted money or how it's allocated, but, instead, it's FAA's long-standing internal management and cultural impediments to improving their acquisition processes.

If we, therefore, intend to greatly improve our national air space system, it will require fundamental changes in FAA's acquisition management.

This hearing is to examine how FAA's research and acquisition activities address the operational requirements of the NAS, from the perspective of the aviation industry.

We will also review how FAA interacts with other federal agencies to establish long-term R&D goals and develop cooperative R&D programs.

Today's hearing will consist of two panels. Panel One, that we have before us, the witnesses will represent various segments of the aviation industry, such as the airline, aircraft and avionics manufacturers, service groups and trade associations.

Our Panel Two witnesses will represent other government and nongovernment agencies which deal directly or indirectly with FAA's R&D activities.

I'm pleased to have our distinguished panelists with us this morning. We're going to proceed with questions, but I really would like to give this panel an opportunity to make maybe a two-minute introductory statement before I proceed with questions.

So if that is acceptable with you, gentlemen, then we will be hearing from:

Dr. John Fearnsides, senior vice president and general manager of the MITRE Corporation, from McLean, Virginia;

Mr. Robert Stevens, who is the executive vice president of Loral Federal Systems, Air Traffic Control. It happens to be in Maryland's 8th Congressional District in Rockville, Maryland;

Mr. J. Roger Fleming, senior vice president of operations and safety at the Air Transport Association, here in Washington;

Mr. Siegbert Poritzky, who is a former member of the FAA R&D advisory committee and the RTCA board of directors, from Bethesda, Maryland.

Is that order okay, if we proceed from your left to right?

So, Dr. Fearnsides, if you'd like to make any opening statement.

STATEMENT OF DR. JOHN J. FEARNSIDES, SENIOR VICE PRESIDENT AND GENERAL MANAGER, THE MITRE CORPORATION, McLEAN, VIRGINIA

Dr. FEARNSIDES. Thank you, Madam Chairwoman.

I've submitted a statement for the record, and I'll just summarize it very quickly.

Mrs. MORELLA. Splendid. It is included. All of your written statements are included in the official record. And we appreciate the synopsis.

Dr. FEARNSIDES. Thank you. I think the conclusion that the Subcommittee reached as a result of its May 16th hearing was right on target. And I think that it's important for us not to focus entirely on acquisition reform, but also the kinds of reforms that really make some fundamental changes in the initiatives and the incentives at the FAA. I've been working with FAA for some years and have seen many administrators try to come to terms with managing a very complex organization, an $8½-billion complex technical operational regulatory organization.

And with the tools that they have available to them, it's almost an impossible job.

I think that, in addition to the personnel and procurement reforms that are being talked about all over the Congress of the United States now, we think that the bill that the Senate, Senator McCain, is crafting that the Administration supports to try to substitute user fees for ticket taxes, could really begin to change some of the fundamental incentives and bring an external management advisory committee to help guide the investments that the FAA

makes to the goal of improving air traffic control system performance.

And I think one of the most important things about FAA's R&D programs to recognize is that, for years, we've been investing in technology. And the time has come to start bringing that technology into the field.

The kinds of research we're talking about now are not the classic kinds of research that people have done in the past, but, rather, what we might call system research and how to really understand the air traffic control system and how its performance could be improved.

For example—and this is my last statement—the airlines now estimate that inefficiencies in the air traffic control system cost them $3-1/2 to $5 billion annually. And we've got to get about getting this technology to the field in order to begin to solve some of those problems, to say nothing of the FAA's budget problems that they'll have to deal with in the next few years.

[The prepared statement of Dr. Fearnsides follows:]

COMMITTEE ON SCIENCE
Subcommittee on Technology
HEARING
AN INDUSTRY PERSPECTIVE OF FAA R&D PROGRAMS
DECEMBER 7, 1995

DR. JOHN J. FEARNSIDES, SENIOR VICE PRESIDENT AND GENERAL MANAGER, THE MITRE CORPORATION, 7525 COLSHIRE DRIVE, MCLEAN, VIRGINIA, 22102-3481

Please consider these comments as written testimony for the record. I intend to address directly the four issues raised in the Hearing Charter. First, however, I want to comment on the conclusion reached by the Subcommittee as a result of its May 16, 1995, hearing on FAA's acquisition management. To wit:

> "the major issues are not the budgeted money or how it's relocated, but FAA's long-standing internal management and cultural impediments to improving their acquisition processes. Major improvements to the NAS will require fundamental changes in FAA's acquisition management."

To make the second sentence of the Subcommittee's conclusion more consistent with the first, I would add that fundamental changes in FAA's <u>culture</u> are needed in addition to changes in acquisition management.

This is an important point especially during this period of discussion of FAA reform. There is an opportunity provided in the Senate Bill S.1239 (the McCain, Ford, Hollings Bill) to take an important step towards FAA reform. S.1239 establishes a user charge financing system to replace the existing ticket tax. More importantly, these user charges are to be established in a way to incentivize the efficiency of both the FAA as an administrative organization and, more importantly, of the National Airspace System itself. Only with such a dramatic change in the accountability and funding of the FAA can there be progress toward dealing with the Subcommittee's conclusions regarding the testimony presented at your May 16 hearing.

Another way of saying this is that acquisition reform without financing and oversight reform will not resolve the issues raised by this hearing. Administrator Hinson, Deputy Administrator Daschle, Dr. Donohue and others have done as much as they can

do without the necessary management tools. This is why the Administration supports the Senate Bill.

My comments regarding the specific issues raised in this hearing should be considered in this context.

1. Will the FAA's research and acquisition plan meet the validated operational requirements of the NAS, considering the activities of all agencies which fund aviation related R&D?

Answer: I am not sure that a validated set of operational requirements for the NAS really exist. As interpreted historically in the FAA, operational requirements pertained primarily to the needs of the operators and maintainers of the NAS: i.e., FAA controllers and maintainers. In recent years it has become evident that there are valid operational requirements of external NAS users: airlines, General Aviation, DoD, etc. Most recently, the aviation community under the rubric of Free Flight has, through RTCA Task Force 3, developed a modified set and ranking of operational requirements. The real questions are what constitutes validation, who (external as well as internal users?) participates in the validation decisions, and what are the institutional mechanisms for achieving validation. Then, once having achieved requirements validation, what are the mechanisms for starting, restructuring or stopping programs?

2. How does the FAA incorporate the expertise of pilots; corporate, regional and major airline management; controllers; technicians; and other industry experts in establishing the operational requirements of the NAS and developing long-term research and acquisition goals?

Answer: In recent years, the FAA has made substantial improvement in getting user participation in establishing R&D goals. The aforementioned RTCA Task Force 3 is an excellent example. Another example is the Service Plan being developed by the Director of Air Traffic Services. However, there is not any mechanism that I am aware of that converts these goals to FAA programs and investments. This issues is really at the heart of FAA reform discussions. For example, the aforementioned Senate Bill S.1239 recently reported out of Committee establishes performance-based user charges intended

both to reflect an accurate accounting of FAA investments and a Management Advisory Committee to advise the Administrator on a distribution of capital investments that more effectively incorporate their operational requirements. Moreover, the external users can take advantage of FAA-developed prototypes and simulations to get a more accurate picture of what is actually being developed to meet those requirements.

3. How does the FAA coordinate its R&D efforts with other government agencies which sponsor aviation-related R&D? Is the coordination effective in gaining synergies of effort and resources while avoiding costly duplication?

Answer: Generally the coordination of R&D efforts with DoD and NOAA is achieved through well-defined institutional arrangements. Similar arrangements need to be defined for the proposed new NASA ATC R&D programs. Some of the NASA programs under consideration have the potential to duplicate existing or completed research. The FAA is working this problem and should get informed assistance from the proposed Public-Private Steering Committee that will be formed as a result of Task Force 3 recommendations. The Aviation Community needs assurance that imminent research products will be expedited to the field and not delayed by a rethinking of well understood concepts.

4. What has been the effect of FAA's most-recent reorganization and its introduction of Integrated Product Teams (IPT)?

Answer: The motivation to create IPTs is exactly right, but structural change alone is not enough to ensure success. The IPTs must accelerate the implementation of much needed operational capabilities to the field. The IPTs need processes that can enable the transition from a major system acquisition to an evolutionary system development paradigm. Specifically, they need to develop new investment decision making, requirements validation, and system development processes. Without these changes and processes, the IPTs will not be able to accelerate the transfer of R&D results to the field. Congressional staff should also understand the new developmental mechanisms in order to provide knowledgeable oversight.

Mrs. MORELLA. Thank you, Mr. Fearnsides. Mr. Stevens?

STATEMENT OF ROBERT J. STEVENS, EXECUTIVE VICE PRESIDENT, LORAL FEDERAL SYSTEMS—AIR TRAFFIC CONTROL, ROCKVILLE, MARYLAND

Mr. STEVENS. Good morning, Madam Chairwoman. Thank you for the opportunity to join you this morning.

As you know, Loral is active through a number of contracts in efforts to modernize various aspects of the NAS system that you referred to in your introductory comments, including the enroute, the terminal, and the tower environment.

In the performance of those contracts, I'm pleased to report this morning that, with a number of minor exceptions, and I emphasize minor, we are on schedule, performing at or favorable to our cost targets on those modernization efforts, and at a level of technical performance that the FAA finds entirely satisfactory.

In the conduct of those programs, we've had significant experience in working with integrated product team management, which is the paradigm that the FAA has introduced to bring the end-users to a more active level of involvement in the front end of the process.

I hope through the opportunity to respond directly to your questions, we can address those issues for you this morning.

Thank you.

Mrs. MORELLA. Mr. Fleming?

STATEMENT OF J. ROGER FLEMING, SENIOR VICE PRESIDENT, OPERATIONS AND SAFETY, AIR TRANSPORTATION ASSOCIATION, WASHINGTON, DC

Mr. FLEMING. Thank you, Madam Chairwoman.

As I have noted in my comments, the earlier hearing in May contained some very valuable insights into problems with the FAA's process, and I highlighted a number of those.

I'd like to touch on a few key points from the airlines' standpoint.

FAA management in the research and acquisitions organization has got to be imbued with several key notions.

First, the ATC system is not just equipment, but it's operating procedures and standards as well. These things have to be brought forward in concert with each other.

Second, the customers are not within the FAA. The customers are people who operate airplanes, passengers, and shippers.

Now the administrator understands this very clearly. But not everybody in FAA management does. Or they're unwilling to concede that point.

Operational personnel need to be more intimately involved in the developmental process. As I stated, operational procedures have to be developed in concert with the technology. And there's got to be greater use made of simulations.

Now several speakers have already touched on the development of integrated product teams. We find that progress tends to be uneven.

But, on balance, we believe this is a positive step in the right direction because it does integrate the research and the development

processes. And in the past, FAA has had difficulties bridging those gaps.

The biggest problem overall that airlines have with the FAA process is that there is no apparent sense of urgency. There is virtually nothing that is in their bill of products to be developed and implemented that satisfies the timeframes that airlines believe appropriate.

Now I think you could readily understand the users being more aggressive about the timelines than the provider, who actually has to do the very difficult job.

I think that's a constructive tension.

Finally, we find that there's a great deal of paranoia in this organization, of impediments that are raised by procurement law or practices as implemented by FAA become barriers to progress.

There needs to be more accountability in this organization. There needs to be more willingness to take prudent risks. And there has to be a balance between the two of those.

Finally, I have noted in my testimony several steps that I think will provide a very useful bridge to the future. The first is the RTCA task force free flight development.

The second is the parallel development of a high-level systems architecture by FAA.

And the third example I cited is the establishment of ATN Systems, Inc., the Aeronautical Telecommunications Network product development concept.

I believe these are all evidence of improved collaboration between the industry and the FAA and I think they provide some useful foundation stones for progress in the future.

Thank you.

[The prepared statement of Mr. Fleming follows:]

Statement of the Air Transport Association of America
Before the House Committee on Science
Subcommittee on Technology, on
An Industry Perspective of FAA R&D Programs
December 7, 1995

Good morning, Madam Chairwoman. My name is J. Roger Fleming. I am Senior Vice President, Operations and Safety, Air Transport Association of America (ATA). ATA represents 21 U. S. air carriers and 3 international air carrier associate members. I am pleased to have this opportunity to present the views of ATA on FAA's Research, Development and Engineering programs. I have intentionally inserted the "E" (Engineering) function in my comments today because recent organizational changes at FAA have blended the research and development functions with the engineering function in the FAA Research and Acquisitions organization -- at least for major ATC systems development and acquisition. I believe that on balance this change at FAA is a beneficial development, but it does not resolve all the outstanding problems. There are residual organizational and management challenges that must be addressed by both FAA and industry.

ORGANIZATIONAL AND MANAGEMENT CHALLENGES

In preparation for this hearing I reviewed the report of your May 16, 1995 hearing on FAA research and acquisition management. I found the testimony of the Office of Technology Assessment witness, Mr. Kevin Dopart, particularly instructive.

I would like to quote from Mr. Dopart's May 16 written testimony because he focussed on the major deficiencies that have plagued FAA's major ATC system development process in the past, and continue to be a concern now, despite a major restructuring at FAA. Mr. Dopart stated:

"OTA finds that R&D management issues have been the primary impediment to ATC modernization efforts. Shortcomings in the FAA process for analyzing and establishing operational requirements and procedures have contributed greatly to chronic delays in ATC system development and implementation.

"Time and again, ATC technologies reach the advanced stage of development before those who are to install or use them discover what was developed is not what was needed. In many cases, operational problems have remained undetected until a prototype ATC system has been completed and procurement is imminent and underway.

"The ATC system is not just equipment, but operating standards and procedures. Both parts of the system must be developed in concert. To accomplish this, **research, development, and engineering for operational requirements and procedures must be strengthened and made an integral part of FAA's ATC system development process.**

OTA concludes that three key steps are needed:

- closely involve experienced operational personnel in the development process,
- develop operational procedures early enough to affect the technology development process, and
- use dynamic simulations as "operational development" tools as well as "technology development" ones.

"A major factor is that technology development has been the dominant tenet of FAA system development programs. As a result, technological improvements, rather than operational advances, have become the focus of many projects... However, communication and coordination among FAA's operational sections and technology developers have been impeded by long-standing cultural differences among these groups, particularly regarding the priorities, knowledge, management methods, and perspectives for ATC system development.

"**OTA concludes that key criteria for more effective atc system development include stable leadership, multidisciplinary development teams that cross organizational and public-private boundaries, and a commitment and understanding**

that ATC system development must be more operationally driven than technology driven."

I have quoted extensively from Mr. Dopart's testimony before this Committee on May 16, 1995 because I share all the views expressed above. I take no pleasure from the recent dismantling of OTA. I believe the organization did credible work, including their testimony on FAA's research and technology acquisition programs.

FAA RESTRUCTURING

The major actions that FAA has taken in response to past criticisms of its development and acquisition practices was described in detail by Dr. George Donohue on May 16, 1995. In his testimony Dr. Donohue described the new organizational and program management and assessment mechanisms that he has put in place to bridge the prior gaps between the research, development and acquisition processes and to get more operational input into the entire process. Focus is now on Integrated Product Teams (IPTs) which are to have life cycle responsibility for major systems development and acquisition. I believe these changes, taken together, are important steps in the right direction. But progress seems to be uneven. Some IPTs appear to be making good progress with their projects. Others are struggling. We find needed operational capabilities missing in some of the programs, especially automation interfaces missing or digital communications links not

included in the planning. Some programs within an IPT overlap in operational capabilities, which could result in system discontinuities if unresolved. Some IPTs seem to have forgotten that there will be airplanes flying in the system and that the airplane capabilities must be compatible with the ground systems if a beneficial result is to be obtained.

One conclusion that I reach is that there are still significant gaps in the systems engineering that is required to make all these discrete ATC system elements come together at the right time and work together efficiently. It is clear that there is not yet adequate coordination with the users in establishing detailed system requirements. Also, airlines are uniform in their view that there seems to be little sense of urgency in the FAA organization. Most major system elements are scheduled for operation years after the airlines believe the capability should be available.

Perhaps it should come as no surprise that such difficulties still exist, since FAA is still in the infancy of the new way of doing business in the systems development and acquisition organization. Paranoia still prevails in the organization: fear that termination of a failing acquisition program will force a new start on the whole process, which is likely to cost 2-3 years delay; fear that a contract protest will obstruct progress and introduce major delay. There is also concern about "requirements creep," which may come from within FAA or outside. Dr. Donohue noted the risk-averse culture in his own organization.

This no doubt results in part from fear of these factors -- factors which are difficult for program managers or IPT leaders to control. If the leadership of the organization and the mid-level managers are unwilling or unable to accept some reasonable level of risk, progress is going to be slow. And that still appears to be the case.

PROMISING DEVELOPMENTS

FAA is developing a high level "Systems Architecture" which promises to help identify all the elements of the ATC system that must be developed, the interfaces and the interdependencies among the elements and timelines for completion of development and acquisition of discrete elements of the ATC system. Such an architectural plan should enable the system users to integrate their planning for aircraft modifications with FAA's systems planning. This systems architecture development has been undertaken by FAA in the same time frame as the development by RTCA Task Force 3 of their Free Flight Implementation report. The RTCA Task Force 3 effort is described in Attachment A to this statement. FAA managers were intimately involved with the RTCA free flight activity, along with a broad cross section of the user and manufacturing community, including the pilot and controller professional organizations.

The RTCA report lays out a road map to free flight implementation. It includes a number of recommendations for research and development work that must be pursued by

FAA, NASA and other institutions. The report is operationally oriented, driven by user benefits and will influence the development of the FAA systems architecture plan. I have hopes that it will serve to further bridge the remaining gaps between the users and the FAA systems development and acquisition organizations, especially with respect to the operational objectives to be implemented. FAA is due great credit for their enthusiastic participation in Task Force 3. But now we must see to it that the necessary implementations steps are taken.

Another promising initiative undertaken by FAA and 11 ATA member airlines is the negotiation of a cooperative agreement that enables a new entity known as ATN Systems, Inc. to undertake collaborative development of new digital communications technology (ground and airborne routers) for the FAA and worldwide Aeronautical Telecommunications Network (ATN). ATN Systems is using government and industry resources to expedite development of a critical digital communications capability, through the prototype stage, which will be essential to full implementation of the free flight concept. I have attached a July 13 FAA press release and letter from FAA Administrator Hinson to ATN Systems President Bill Cotton (of United Airlines) that describes the broad objectives of the Cooperative Agreement. In addition, Attachment B includes commentary from the ATN Systems Program Manager, Mr. Michael E. Murphy, on the issues being considered

by this Committee today. Mr Murphy works closely with the FAA ATN Program Manager, Mr. Hal Ludwig, several of the FAA IPTs, ATA staff and member airlines, and RTCA.

SAFETY RESEARCH

I do not intend to review the adequacy of FAA's safety research programs today but would like to suggest an approach to such an analysis that the Committee may find of interest. In January, 1995 the Secretary of Transportation and the Administrator convened a "Safety Summit" meeting that produced an Aviation Safety Action Plan titled, "Zero Accidents... A Shared Responsibility." That action plan is being reviewed and refined today at another meeting of government and industry safety experts. When the revised Aviation Safety Action Plan is made available for review, I recommend that FAA's aviation research program, as well as related NASA research activity, be evaluated to see if the agencies' resources are being directed to the objectives that the safety summit experts have identified as those deserving the highest priority.

SUMMARY

In summary, Madam Chairwoman, it is clear that there are still management problems hindering the FAA Research, Engineering and Development programs.

Better FAA coordination is needed, both within the agency and with the outside aviation community. But significant progress has been made in the FAA restructuring of the Research and Acquisition organization and the improvements should not be discounted before there has been sufficient time to mature the new organization.

The development of a Systems Architecture, consistent with and supporting the operational objectives developed by RTCA Task Force 3, as specified in the Free Flight Implementation Report, should better focus development efforts of FAA and the entire aviation community. The ATN router development activity is an innovative government/industry collaboration that will contribute positively to implementation of the free flight concept and can serve as a model for other collaborative development projects. These efforts, if managed well, should enable much of the past criticism of FAA's research, development and acquisition programs to be put to rest. Support from this Committee in pursuit of these objectives would be highly appreciated by all members of the aviation community.

This completes my statement, Chairwoman Morella. I would be pleased to answer any questions you or your Committee colleagues may have.

Attachment A

RTCA Task Force 3

"Free Flight Implementation"

Evolution of Free Flight

The concept known as Free Flight was introduced in a 1981 FAA Report entitled *"Operation Free Flight - An Operational Evaluation of RNAV Direct Route Flight Plan Filing in Today's National Airspace System."* The Free Flight concept has been redefined and advanced by the user community and FAA in a collaborative effort undertaken by RTCA Task Force 3.

In late 1994, the RTCA Board of Directors formed a Select Committee on Free Flight. The committee was Chaired by Mr. L. Lane Speck, Director, FAA Air Traffic Rules and Procedures Service, and included representatives from the airlines, general aviation, the Department of Defense, the pilots union, the air traffic controllers union, the FAA and a few support personnel. It developed consensus on the definition of Free Flight and codified both the Free Flight concept and the principles on which it is based. Free Flight was defined as:

> "A safe and efficient flight operating capability under instrument flight rules (IFR) in which the operators have the freedom to select their path and speed in real time. Air traffic restrictions are only imposed to ensure separation, to preclude exceeding airport capacity, to prevent unauthorized flight through special use airspace, and to ensure safety of flight. Restrictions are limited in extent and duration to correct the identified problem. Any activity which removes restrictions represents a move toward Free Flight."

The Select Committee's report was forwarded to the FAA Administrator as a "white paper" for review and appropriate action during January 1995.

On April 20, 1995, FAA Administrator Hinson wrote to RTCA and stated, in part, "...RTCA, with FAA assistance developed a Government/industry consensus regarding an earlier initiative, the Transition to the Global Navigation Satellite System (GNSS). We request that RTCA assist in a similar way to develop community consensus regarding Free Flight implementation." He went on to ask that RTCA form a new task force, led by an appropriate representative from the civil aviation community to "...provide us with a recommended implementation strategy and transition plan for Free Flight that uses ... the *Report of the RTCA Board of Directors' Select Committee on Free Flight* as a point of departure, fully identifies user requirements and expected benefits, outlines suggested procedure changes, recommends appropriate implementation of technology, and offers a

suggested implementation schedule as well as a means of coordinating the attendant Government and industry activities. A draft report by August is required in order to meet our budget preparation schedule, and the task force report needs to be completed by the end of October."

To put the FAA Administrator's request in context, RTCA is a private, not-for-profit corporation that addresses requirements and technical concepts for aviation. The organization was formed in 1935, functions as a Federal Advisory Committee and its consensus-based recommendations are used as a basis for government and industry decisions as well as FAA Technical Standard Orders. FAA presented RTCA with the prestigious International Civil Aviation Organization (ICAO) 50th Anniversary Medal of Honour in recognition of its accomplishments and many contributions to " ...not only America's but the world's, global air transportation system" during the 1944 - 1994 period.

RTCA accepted the Administrator's request. Mr. Richard W. Taylor, a retired Boeing Vice President agreed to be the volunteer Task Force Chairman. RTCA then formed a Task Force Steering Committee that included international representation and launched the Task Force activity. Over 250 volunteers from across the spectrum of the aviation community worked from May 1995 through October 1995 fleshing out operational concepts and procedures, outlining a Free Flight implementation architecture, selecting appropriate technology and defining a viable transition strategy. The interim report was delivered to the Administrator on schedule. He endorsed the interim report recommendations and made it available to the participants of the ICAO 31st General Assembly which took place in Montreal, Canada, September 19 - October 4, 1995.

The Task Force final report, which reflects the results of the Task Force deliberations and includes 46 time-phased recommendations, was delivered to the FAA Administrator October 31, 1995. Initial reactions have been very positive. FAA will formally respond to the report during early January 1996.

A very brief summary of report highlights follows.

REPORT OVERVIEW

Basic Principles

The transition to Free Flight will be benefits driven, time-phased and will not compromise safety. These were the primary principles used in guiding Task Force deliberations and in developing Task Force recommendations.

Benefits will generally be measured in terms of increased access to airspace and increased flexibility in the conduct of aircraft operations, e.g., increased flexibility to fly

"direct" or other more operationally advantageous routes, and/or to fly at operator preferred air speeds and altitudes. Furthermore, the transition should occur in small incremental steps where aircraft operators will immediately receive operational benefits when they upgrade aircraft avionics. An underlying principle is to encourage aircraft equipage by providing benefits rather than by imposing equipment mandates or operating limitations. The Task Force placed special emphasis on what can be done now to provide significant operational benefits at low cost and low implementation risk using proven technologies.

Another major guiding principle was the need for much more collaboration between government and industry -- collaboration regarding the provision of benefits in exchange for the investment and use of new equipment and collaboration regarding the exchange of strategic and tactical flight planning information, e.g., anticipated traffic flow restrictions and the attendant diversion/recovery of aircraft at a given airport. There must be a greater exchange of real-time information.

Free Flight Concept

Under the Free Flight concept, pilots will be able to operate without specific route, speed or altitude clearances. A flight plan will be available to the air traffic controller, henceforth referred to as the air traffic service provider, to assist in traffic flow management. However, a flight plan will no longer be used as the basis for separation. Aircraft position and short term intent information will be provided to the air traffic service providers who will monitor aircraft flight path and separation information. This information will also be provided to nearby aircraft.

During normal operations, aircraft maneuvering will be unrestricted and separation assurance will be enhanced by appropriate on board systems. Air traffic service providers will only intervene to issue short term restrictions when two aircraft are in contention for the same airspace.

Protected and Alert Zones

Under the Free Flight concept, each aircraft will be surrounded by two zones: a Protected Zone and an Alert Zone. [See Fig 1]. The Protected Zone, which is the smaller, inner zone, must remain sterile to assure separation. Its size will be distance based and will be a function of the accuracy of aircraft position information. The Alert Zone, which is the larger, outer zone, will be used to identify a condition where intervention may be necessary. The size of the alert zone will be time based rather than distance based and will be determined by aircraft speed and performance characteristics as well as aircraft equipage.

Aircraft separated from other aircraft such that their respective alert zones are clear, will be free to change course, altitude and speed at will. After any change, a revised plan

will be data linked to the ground for planning purposes. When the alert zones of two or more aircraft touch, the air traffic service provider will assess the potential for conflict and issue preventive advisories or resolution instructions as necessary. The availability of highly accurate, real time aircraft position and velocity information plus advanced decision support systems that can probe this information for potential conflicts will be fundamental to system operation.

Dynamic Density

Dynamic density is the term used to characterize the air traffic in a given volume of airspace. It is a function of traffic density, the complexity of the traffic flow (e.g., the number and speed of arriving, departing and merging aircraft as well as the avionics carried by these aircraft) and aircraft separation standards.

Air traffic service providers will determine the level of Free Flight that can be accommodated in a given volume of airspace as dynamic density varies. Increasing dynamic density could mean that users will have to adhere to their stated intentions and advise the air traffic service provider before changing course, air speed or altitude. It could also mean that users will be advised of the likelihood of restrictions and thereby let users make their own decision about operating in that airspace.

Modeling and simulation will be needed to postulate and assess the location, timing and potential operational ramifications attendant with changing dynamic density scenarios. Decision support system tools will also be needed to help air traffic service providers anticipate and accommodate changing dynamic density situations.

Aircraft Separation Standards

Aircraft separation standards are based on the accuracy and timeliness of aircraft position and velocity information coupled with the performance of available communications, e.g., the ability to accurately and reliability exchange real time information. Given the more accurate aircraft position and velocity information, improved communications and appropriate decision support systems now available through the use of current technology, it should be possible to reduce the size of protected and alert zones thereby reducing dynamic density and increasing the capacity, efficiency and safety of air transportation. With the installation and use of appropriate avionics plus agreement between the air traffic service provider and aircraft pilot, responsibility for aircraft separation assurance may, under some circumstances, be passed to the aircraft.

Architecture and Technology

The system architecture needed for Free Flight is based on the implementation of new hardware and software that will exploit modern technology and the use of new procedures that will take full advantage of more accurate and more timely aircraft position and vector information. The Task Force recommended an architecture that ascribes Free Flight requirements to avionics and air traffic infrastructure elements and outlines how available or new technology can be applied to meet these requirements.

From a technology perspective, Free Flight will:

- make extensive use of digital data and voice communications for air traffic management, airline operational control and administrative communications.

- place heavy reliance on the use of the Global Navigation Satellite System for very precise aircraft positioning information for en route navigation, for precision departures and arrivals at airports and as a source of universal time.

- depend on the use of Automatic Dependent Surveillance-Broadcast, a surveillance technique that uses digital communications and very precise aircraft position, vector and short term intent information, to inform air traffic service providers and other aircraft about proximate traffic.

- make increasingly greater use of new, much more capable decision support (automation) systems for use by air traffic service providers to help them meet their responsibilities.

- include new displays, both in aircraft and at air traffic management facilities, to provide operational personnel with current, accurate situational awareness.

New air traffic procedures, the other basic element of the Free Flight architecture, will capitalize on the accuracy and timeliness of digital communications, satellite-based navigation, computer-based decision support systems and displays to increase safety, capacity and efficiency while simultaneously reducing separation minima and enabling all equipped aircraft to fly the route that best meets aircraft mission requirements at the preferred altitude and air speed.

Transition Strategy

The transition from today's air traffic control system via Free Flight to an air traffic management system for the 21st century is truly a major systems engineering and integration challenge. Implementation will require very close coordination among the many

and diverse public and private organizations that are involved. Not only will schedules for the acquisition of new equipment and the implementation of new air traffic procedures need to be coordinated, but the performance standards used in the design of the new hardware and software will require close coordination to assure interoperability. Furthermore, new procedures will be needed to assure the timely end-to-end certification of the new system elements, thereby assuring both government and industry derive prompt and full benefit from their investments in the new concepts, new technology and new procedures.

Recommendations

The Task Force concluded by making 46 specific recommendations. A dominant recommendation is, "Within six months after FAA receives the Task Force report, a government/industry Free Flight Steering Committee, formed under the auspices of RTCA as a Federal Advisory Committee, should meet. The objectives of this committee should be:

- to establish an agreed-to implementation strategy and milestones.
- to periodically review government and industry progress in meeting implementing commitments, via the use of appropriate metrics.
- to identify new Free Flight implementation opportunities as well as events/situations that re inhibiting progress and review actions that are taken."

The 46 recommendations were grouped by time frame. Of these,

- 37 are categorized as Near-Term (Present through 1997), in general require minimal investment and are largely procedural in nature, e.g., make greater use of area navigation capabilities already installed in many aircraft;
- 6 are identified as Mid-Term (1998 - 2000) and call for the application of existing technology, e.g., accelerate and expand programs to support the GPS/Wide Area Augmentation System as a primary navigation system; and
- 3 are listed as Far-Term (2001 and Beyond) and point toward new operational capabilities requiring a greater amount of analysis, modeling and development, e.g., implementing operational use of a GPS Local Area Augmentation system, for precision approaches and departures.

FAA Administrator Hinson has stated, "This report will help point us in the right direction as we work to implement the vision of Free Flight and to help guide our steps in

developing the National Air Space system architecture that will help make Free Flight possible. Currently the report is being reviewed internally and we will provide a formal response to the recommendations of Task Force 3 in early January."

Conclusion

The aviation community stands at the threshold of a great opportunity to safely re-order the air traffic system. New technology—specifically GPS—now makes practical the ideas and concepts that have long been desired and discussed. The air transportation community has a clear vision of where, how and when it wants to proceed. Working collaboratively, government and industry can achieve the many benefits of Free Flight.

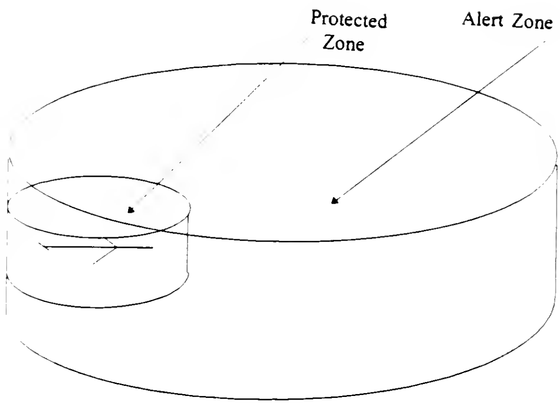

Figure 1: Protected and Alert Zones

SYSTEMS, INC.

Attachment B

ATN Systems, Inc. (ATNSI) is a consortium of eleven U.S. air carriers formed in June 1995. It was created to enter into a Cooperative Agreement with the Federal Aviation Administration (FAA) to develop data communications equipment for aircraft and FAA ground systems to enable enhanced Air Traffic Services and the migration towards Free Flight. The ATNSI air carrier owners are:

Alaska Airlines	Hawaiian Airlines
American Airlines	Northwest Airlines
American Trans Air	United Airlines
Continental Airlines	United Parcel Service
Delta Airlines	USAir
Federal Express	

This Cooperative Agreement between the FAA and ATNSI permits a consensus oriented process to develop system requirements and will result in mutual acquisition of appropriate system elements to bring about significant operational improvements in the National Airspace System (NAS) in a time frame much earlier, and more cost-efficient than could be done using the FAA acquisition process.

This Cooperative Agreement model is strongly supported by industry and is serving to improve and resolve NAS developmental issues, such as those identified by the COMMITTEE ON SCIENCE, Subcommittee on Technology. In regard to these issues, ATNSI would like to make the following points:

1. Will the FAA's research and acquisition plan meet the validated operational requirements of the NAS, considering the activities of all agencies which fund aviation related R&D?

Current FAA plans do meet the validated operational requirements of the NAS but not in the time frame expected by industry. Delays in the introduction of enhanced capabilities directly result in cost expenditures that could be used towards system procurements. The Cooperative Agreement is a model that could continue to be used to shorten the FAA acquisition process and improve the efficiency of directed funding.

2. How does the FAA incorporate the expertise of pilots; corporate, regional and major airline management; controllers; technicians; and other industry experts in establishing the operational requirements of the NAS and developing long-term research and acquisition goals?

Although there are an extensive number of forums and processes that the FAA uses to establish NAS operational requirements, the Cooperative Agreement is a model that builds consensus into the system requirements and system development process. ATNSI is considering the inclusion of additional participants, such as corporate and regional carriers, and does work closely with FAA organizations and industry experts in the development of system requirements in its current projects.

3. How does the FAA coordinate its R&D efforts with other government agencies which sponsor aviation-related R&D? Is the coordination effective in gaining synergism of effort and resources while avoiding costly duplication?

Again, there are an extensive number of forums and processes that the FAA uses for coordination. ATNSI, in cooperation with the FAA, is recognized, and does work closely with other government agencies, such as NASA, to informally facilitate the development of system requirements and relevant program priorities.

4. What has been the effect of FAA's most-recent reorganization and its introduction of Integrated Product Teams (IPTs)?

ATNSI works closely with FAA IPTs and applauds the reorganization and the improved responsiveness of the FAA.

1301 Pennsylvania Avenue, NW • Suite 1100 • Washington, DC 20004
Telephone (202) 626-4157 • Facsimile (202) 393-7934

U.S. Department of Transportation

News:

Attachment B
Addendum 1

Office of the Assistant Secretary for Public Affairs
Washington D C 20590

FOR IMMEDIATE RELEASE
Thursday, July 13, 1995

APA 83-95
Contact: Jeffrey Thal
Tel.: (202) 267-7344

FAA, AIRLINES ANNOUNCE LANDMARK AGREEMENT TO FURTHER AERONAUTICAL COMMUNICATIONS

Continuing the Clinton Administration's effort to reinvent government, the Federal Aviation Administration (FAA) today announced that it and 11 U.S. airlines will establish an unprecedented government-industry consortium to develop the framework for a worldwide Aeronautical Telecommunication Network (ATN). The state-of-the-art system will enable airlines and other airspace system users to communicate rapidly and reliably worldwide well into the 21st century.

The agreement, which completes an action item set forth in the administration's National Performance Review, establishes a working model for government/industry cooperation in the development of a worldwide standard for aviation communication.

"This is an example of government/industry cooperation at its best because it is designed to speed delivery of a system to improve safety and service, and at the same time reduce the costs of the system's development to the users and taxpayers," said FAA Administrator David R. Hinson. "By demonstrating a clear need for the network and a commitment to work together, FAA and the aviation industry hope to reduce the risk for equipment manufacturers and create an early market for ATN products."

-more-

Under the consortium agreement, the airlines have formed a corporation, ATN Systems, Inc., that will work with the FAA to develop the systems to meet the requirements of the various airspace users. The FAA and the airlines will work together to foster commercial development of the equipment and systems required for the network rather than taking the traditional approach of having the aviation industry and the government conduct separate lengthy and costly development programs.

"This type of working relationship was a recommendation of the President's 1993 National Commission to Ensure a Strong Competitive Airline Industry. It enables us to save money and time in the development of standards for systems such as the ATN," said Hinson. "The result of this particular effort will be faster, more efficient and more reliable communication of data for the improved safety and benefit of all users of the airspace system--airlines, military, business, private pilots and the flying public."

"ATN data communications are the key to meeting the air traffic management needs of the future," said ATN Systems, Inc. President Bill Cotton. "The ATN will be an interconnected, worldwide system that will verify and communicate accurate information about the location of all users, including aircraft in flight, to all users of the network."

"The airline industry is excited with this innovative approach to new technology development, and ATA is pleased we were able to play a part in the project," said Air Transportation Association (ATA) president Carol Hallett. "Technology and new ways of doing business go hand-in-hand, and the industry will be looking at the ATN system as a model for other future efforts."

Today's aeronautical telecommunication system is a combination of very-high frequency (VHF) and high-frequency (HF) voice and data transmission systems that will not be capable of handling the projected demands of the future. Over the next decade, for example, the FAA expects air travel in the U.S. to increase by 60 percent, from 500 million to 800 million passengers annually, and to double by the year 2015. The ATN will incorporate the elements of satellite communication with a ground-based distribution system to meet these new needs.

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Attachment B
Addendum 2

U.S. Department of Transportation
Federal Aviation Administration

Office of the Administrator

800 Independence Ave. S.W.
Washington, D.C. 20591

JUL 13 1995

Captain William B. Cotton
President, ATN Systems, Inc.
1301 Pennsylvania Avenue, NW
Washington, DC 20004-1707

Dear Captain Cotton:

The Federal Aviation Administration (FAA) is pleased to participate with ATN Systems, Inc., a company owned by 11 airlines, in the establishment of this cooperative agreement. This agreement will enable the collaborative development of the Aeronautical Telecommunications Network (ATN) Router, a key component of Free Flight technology.

This collaborative effort is an example of government/industry cooperation at its best, because this equipment will benefit airspace users and operators by enhancing safety and permitting more efficient use of the airspace. It will also save money for taxpayers and users by expediting the router development. By establishing a clear need for and strong commitment to the network, and through finding a better way to work together, the FAA and the aviation industry expect to reduce the risks for ground and avionic equipment manufacturers, create an early market for ATN products, and deliver the operational benefits to the airspace users more quickly.

I applaud all organizations involved in this innovative, cooperative, and cost-effective approach to system development. The ATN will enable the aviation community to meet the increasing demand for aviation services in the United States and internationally. You have the FAA's full support.

Sincerely,

David Hinson

David R. Hinson
Administrator

Mrs. MORELLA. Thank you very much. You've all been pretty succinct.

Mr. Poritzky?

STATEMENT OF SIEGBERT B. PORITZKY, FORMER MEMBER FAA R&D ADVISORY COMMITTEE AND RTCA BOARD OF DIRECTORS, BETHESDA, MARYLAND

Mr. PORITZKY. I'll try to do the same. Thank you very much.

I need to say before I begin that the statement that I've offered is also offered on behalf of the Airports Council International of North America.

The answers to the questions may not be, however.

[Laughter.]

I've been watching FAA for a long time and I've attempted to understand why things don't happen as rapidly as they should, why the decisions that need to be made take so long to make.

I think I want to make just three very basic points because I think they represent the root of the problems.

The basic decisions on what improvements and innovations need to be pursued and the implemented by FAA must be directed hands-on, from the highest levels of FAA management; certainly above the individual services which represent special interests in themselves, as has already been implied.

The views of the aviation system users must be sought and given important weight, in development and implementation decisions, because of the balance of what's in the airplane and what's on the ground. But they also represent special interests.

The final decisions, usually agonizing and controversial, almost always sure to gore somebody's ox, must be made by fully-qualified and fully-involved top management.

Second point.

The administrator needs help to be able to make those crucial decisions in a timely manner, decisions which almost always involve tough choices and high technology issues.

It's long been recognized by most observers, outside FAA and inside, that a system process and a dedicated small system team are needed. Such a team, made up of the best and the brightest from across the FAA, needs to be established very high in FAA's organization—not in the bowels, but at the level of the administrator or just below him.

It needs to be empowered to analyze and recommend aviation-wide solutions, system decisions, and development implementation, with clear deadlines set by the administrator himself, to assure decision-making doesn't drag on interminably to oblivion.

And we've got lots of those examples.

Finally, FAA's extremely difficult and demanding job is often belittled because of its magnitude, its technology, its emphasis on safety and the participation of thousands of people every minute of the day. It's a far tougher job than most of the glamour technical miracles we marvel out.

The job can't be done without a dedicated corps of highly competent, fully qualified scientists, engineers and other discipline experts.

We've permitted FAA's level of expertise to deteriorate dramatically over the last 20 years.

Of course there are good people at FAA, but they are now so few, that they can no longer even manage the work of FAA's contractors wisely. And contractors working alone without guidance are sure to fail—and I'll offer you dozens of examples of that.

FAA's top management has for many years not emphasized the education and continuing higher education of its people. There are many excuses and rationalizations available. But the raw fact is that FAA's job can't be done without an influx of new capability into FAA and a clear dedication to their continuing education.

Thank you.

[The prepared statement of Mr. Poritzky follows:]

Statement of Siegbert B. Poritzky
House Committee on Science, Subcommittee on Technology
Hearing on An Industry Perspective on FAA R&D Programs
December 7, 1995

The Management and Implementation of Innovation in FAA

I would like to make just three points in this statement:

• The basic decisions on what improvements and innovations will be pursued and then implemented by FAA must be directed hands-on at the highest level of FAA management, certainly above the individual services, which represent special interests themselves. The views of the aviation system users must be sought and given important weight in development and implementation decisions, but they also represent special interests. The final decisions, usually agonizing and controversial, and almost always sure to gore somebody's favorite ox, must be made by fully qualified and fully involved top management.

•• The FAA Administrator needs help to be able to make those crucial decisions in a timely manner, decisions which often involve tough choices and high technology issues. It has long been recognized by most observers - outside FAA and in - that a system process and a dedicated small system team are needed. Such a team, made up of 'the best and the brightest ' from across the FAA, needs to be established very high in the FAA organization - optimally at the Administrators's or the deputy's level. It needs to be empowered to analyze and recommend aviation-wide solutions, system decisions and development/implementation - with clear deadlines set by the Administrator to assure decision-making does not drag on interminably to oblivion.

••• FAA's extremely difficult and demanding job is often belittled. Because of its magnitude, its technology, its emphasis on safety, and the participation of thousands of people every minute of every day, it is a far tougher job than most of the glamor technical miracles we marvel at. The job can't be done without of a dedicated corps of highly competent, fully qualified scientists, engineers and other discipline experts.

We have permitted FAA's level of expertise to deteriorate dramatically over the last twenty years. Of course there are good people in FAA, but they are now so few that they can no longer even manage the work of FAA's contractors wisely. Moreover, FAA's top management has for many years not emphasized the education and continuing higher education of its people. There are many excuses and rationalizations available, but the raw fact is that FAA's job can't be done without an influx of new capability into FAA, and a clear dedication to their continuing education.

What follows are simply elaboration and background.

Official Views of the Industry

Much of what is said in this statement is not new. Most of the basic points have been made by industry trade associations, by informed individuals, by the Coalition of Aviation Associations, and by experts from Capitol Hill and from managers high in FAA itself.

(SBP note: In the following material the italics are mine)

In 1992 and again in 1993, I had the privilege, as a member of the FAA R&D Advisory Committee, to work on an R&D Plan Review Panel made up of a small group of seasoned warriors of the R&D battles, led by Norman Augustine. The report is, in my view an excellent reference, and still a good way forward. To quote only a few of its recommendations:

"The FAA needs the internal capability to exploit as well as to contribute to the generation of [this] new technology if it is to enhance the performance of the nation's air transportation system."

"In comparison with other high quality, technologically dependent organizations, whether government and commercial, the FAA investment in the creation of technology is at or near the lowest level of any comparable organization [in the statistics examined by the Panel]" .

"Recommendation 3. *The Panel recommends that the FAA take steps to enhance competitiveness in acquiring and retaining highly qualified technical personnel*, including fully utilizing recently approved government-wide personnel legislation; and that it *establish centers of excellence at selected universities to address FAA-related issues and train a cadre of future leaders".*

"Recommendation 4. The Panel recommends that the process for establishing requirements and justifications for the technology programs draw heavily on upon the FAA's operating organizations and users' stated needs, *but that the research and development organization also be encouraged to pursue promising technology possibilities and innovations even though they may not yet have the support of users or operating services".*

In June 1993, the National Aviation Associations Coalition, comprising 24 major organizations, responding to the National Commission to Ensure a Strong Competitive Airline Industry, was very direct. They said:

The FAA Administrator (with stable tenure and balanced aviation experience) must ..

•

- *have the authority to organize the Agency without bureaucratic "red tape" and delays and maintain a personnel structure appropriate to the needs of FAA, including the ability to select managers on merit alone*
- be assured of consistent funding (at least 3-5 year authorization/appropriation for all programs concurrently), avoiding continuous changes in priorities and amounts.
- *have the authority to discharge or relocate personnel, as well as to promote and reward competence, and the opportunity and funds to hire a substantial number of promising, technically-current scientists and engineers to ensure a high level of excellence.*
- be granted relief from excessive, non-productive oversight of FAA's activities.

On FAA Personnel/Management difficulties, the Coalition was equally forthright:

- *The FAA Facilities and Equipment program has grown ten-fold in the last few years, while staffing has*

remained essentially static [SBP note: and has declined a great deal since 1993]. Outside support contractors cannot substitute for a cadre of capable insiders.

• *FAA in recent years has been buffeted by reductions in its force of technical experts and by loss of a great deal of its technical leadership, even as demands on FAA have grown dramatically.*

• *To FAA's detriment, the emphasis on continuing and advance education has declined, and the lines between the various disciplines [SBP note: within FAA] have been drawn ever more sharply, rather than being eliminated.*

In August 1993, the National Aviation Associations Coalition, this time including 20 major aviation organizations urged FAA to make early decisions on a number of system issues which then - and now - need to be resolved. Listing 16 such issues, the Coalition noted that

"...a number of major issues and tasks as well as other major challenges facing FAA must be resolved. *They require above all a willingness by FAA to make difficult decisions - usually with less-than-perfect data.... In many cases the issues require primarily management decisions based on experience and judgement.* In other cases system engineering analysis to support decisions...."

Recent Congressional Actions to Encourage, Direct and Prod Change

In looking over these recommendations and urging, it is gratifying to see that after all the fury, and all the conversations over this organization and that, there has been Congressional action which will surely enable the FAA top managers to make changes:

The following paragraphs report on several Congressional actions:

- The current appropriation "directs the Secretary of Transportation to develop and implement a new personnel management system for the FAA (Sec.350)". It also "directs the Secretary to develop and implement a new acquisition management system for the FAA (Sec.351)."

- The report language notes that "Sections 350 and 351 ... provide that *funds provided for FAA operations and capital improvements are exempt from various Federal personnel and procurement requirements*. This will result in the more efficient modernization of the ATC system, and in a more efficient and cost-effective deployment of the air traffic control work force. This does not, however, do away with the need for fundamental reform of the budget process with regard to air traffic control. It is intended only as an interim step toward a reformed air traffic control structure".

- Last year Congress created a six-year term for the FAA administrator to illustrate the need for stability and to try to improve on the chronically short tenure of administrators [SBP note: ..and presumably attention span].

- Finally, this year's conference report language notes an FAA study which concluded that, while the conferees have a high regard for the work of FAA's support contractors, FAA uses "far too many support contractors, that agency personnel could be far more cost-conscious in their contracting and oversight methods, and that in many cases, contract employees are collocated with FAA

staff and virtually indistinguishable from government employees." It directs FAA to respond by March 1996.

The Challenge to FAA

These seem to me to be potentially potent weapons, if the FAA administrator is permitted to use them, and if he is willing to undertake the very tough challenge that these tools imply.

The Congressional action, with luck, will allow the FAA Administrator, his own powers strengthened, to create a new procurement process with the necessary flexibility to modify and adapt contracts to benefit from practical realities. It will permit him(given the appropriate authority from the DOT Secretary) to create a new personnel system that rewards merit, and that permits the FAA to hire an adequate-size staff of competent technical experts, managed to produce results instead of rules. The boss must have the ability to hire, fire, and reward people.

The changes will be difficult to make, and will win the administrator no popularity contests inside, but they are surely worthwhile.

There is a broad view in the industry that there must be major improvements in the acquisition/procurement process and in personnel management, but because the problems are endemic to government, not just to FAA, change will be difficult to achieve. Yet there may be hope in the valid assertion that FAA is unique because it provides a 24 hour-a-day operational service on which the whole aviation infrastructure depends absolutely.

As Congress has noted (and as FAA is fully aware), a disproportionately large part of the FAA's budget goes for support contracts of various kinds. This is the direct result of FAA top management decisions in the early 1980s not to increase the FAA's internal personnel as the F&E task grew about tenfold. FAA's people numbers have been kept very low even as its job has grown bigger. Its internal capabilities have been eroded by continual staff reductions, inability to hire and reward competent people, and the rigidities of the civil service system.

Another consequence of the decision to proceed with the major NAS Plan effort without an increase of FAA's internal complement was that R&D for all practical purposes stopped. The available staff, already small because of reductions during the Carter administration, were needed to administer the new procurement and in effect became program/project managers. A small beginning to rejuvenate R&D was made during the Busey administration, but it was only a feeble beginning.

Contractors can do marvelous things if, and <u>only</u> if, they are led by smart FAA insiders, qualified, dedicated people within the FAA to provide leadership. FAA may well no longer have the internal expertise needed to effectively manage and control its many contractors and helpers. Yet, the government will reduce the body count of federal employees. The special needs of FAA as a 24-hour operating agency must be dramatized if there is to be relief.

Over the past decades there have been frequent FAA reorganizations. Most schemes, except those involving 'corporatization' and privatization, have been tried over the years, with limited success. In November 1994, the agency was reorganized one more time. The current organization is intended to consolidate agency functions, is structured around the agency's major products and services, and was intended, like all such reorganizations, to increase management accountability.

The Management of Research and Acquisitions - Opportunities and Problems

Turning to the Research and Acquisitions organization (ARA), it is intended to handle all FAA activities from research and development through acquisition. At the heart of the new ARA organization are Integrated Product Teams which share life-cycle responsibility for their products with the Airway Facilities organization. This responsibility is intended to extend from applied research through acquisition and beyond, even to the point of ensuring that equipment is up and working properly after it has been delivered and installed in the field. (There are small separate ARA elements to deal with aircraft safety, airport technology and information management matters)

The head of the ARA organization, George Donohue, has said that the key to success is close coordination with Air Traffic Services 'to get functional requirements' built into the process from the very beginning, and an emphasis on 'working together toward a common vision of the future.' Air Traffic and Airway Facilities representatives are intended to participate in the Integrated Product Teams, along with logistics, testing, and contract personnel; system and specialty engineers; lawyers; and others. Users are also intended to be involved in the process. The whole idea behind the integrated product development concept, said Donohue, is to bring together the necessary functional disciplines to streamline the process, cut down on the time it now takes to field equipment and systems, provide better quality control, and reduce life-cycle costs.

It is to be noted that this reorganization blurs the line between what was left of "R&D" and the rest of the acquisition process. The Integrated Product Teams appear to be primarily acquisition and contract managers, and it may be difficult for them to do much "R&D". It is of course widely understood that FAA has traditionally done little research and a lot of development.

The most recent reorganization, like the many others before it, can work with the right mix of people and consistent, hands-on leadership from the top. Yet, it is almost axiomatic that any major reorganization creates a hiatus. The recent, virtually wholesale FAA management turnover, along with a mass exodus of experienced senior people, has wrought major problems. The promised further reductions in personnel can only make it worse.

There are problems in the ARA. In a well-intended attempt to change the R&D "culture" to produce results, a major organizational upheaval occurred in which a number of managers were shuffled far out of their expertise, to be challenged by work with which they were often unfamiliar. This idea might be successful if there had been a large pool of expert subordinates, but caused major problems because the ranks are so thin.

Perhaps more important is the absence of a fully empowered high level system

engineering organization. As noted above, it has long been recognized by most observers outside FAA as well as by those inside, that, to help the administrator, a system process and a dedicated small system team are needed. Such a team, made up of 'the best and the brightest,' and established very high in the FAA organization - optimally at the Administrators's or the deputy's level - needs to be empowered to recommend aviation-wide solutions to serious issues.

Instead, system engineering is relegated down in the ARA organization. The well-intentioned Integrated Product Teams, which would be a very good idea if there were a strong top-level centralized system integration/engineering function, seem to have only fragmented further an already fragmented structure.

A bright sign - there is a concerted effort under way to create a system architecture for the future. The architecture, which hopefully will include some of the crucial and long-delayed major system decisions discussed above, first announced for this fall, is now to be made available to the industry for comment next February.

The Shrinking and Aging Workforce

In addition to the very serious shortfall of experts in the new-technology fields, FAA's work force has been shrinking for at least 15 years, and is now faced with the double-whammy of forced, essentially arbitrary reductions of the whole federal work force <u>and</u> Congressional actions which have weakened the retirement system. Add to that the fact that FAA planned personnel reductions to coincide with the introduction of the new and more reliable facilities, facilities which in large part have appeared far later than planned and require the coddling of old equipment, and automation which for all practical purposes hasn't materialized at all, and a tough problem emerges. It is the sort of problem which requires drastic action and unusual and probably expensive remedies - unpopular in the present circumstances - but necessary.

FAA's Top Leadership - The Most Important Challenge

FAA's job is to operate and continually improve a gigantic, highly complex system of people, facilities and procedures. It operates in real time and has a mandate, successfully carried out over many years, to safeguard the millions who travel.

We give many jobs to the FAA administrator - from manager of a vast infrastructure to cheerleader for aviation, to labor/management arbitrator, to full-time pacifier of clamorous government and industry interests and much more. The job which this hearing is about, however, is about the management of change and innovation - leading FAA itself and a conservative industry into the future of new technical possibilities and new ways of doing things. It is surely a full-time task of a technical manager with a keen appreciation of techno-politics and the ability to drive and make decisions.

A relatively recent initiative, perhaps in anticipation of major structural change, or perhaps because it seemed prudent to use politically correct language, has tried to divide FAA into a group of semi-autonomous "businesses," charged to operate as independently as practical. While this sounds impressive, it is probably not one of the better of the many organizational arrangements which have been tried.

The several major organizational elements of FAA - Air Traffic; Flight Standards & Safety Regulations; Airports; Policy, Environment & International Aviation; and Research & Acquisitions must work in an integrated and harmonized way because they must be, or certainly should be interdependent. While hypothetically the major organizations will work together and by some magic make the big decisions, the reality is otherwise. Inevitably the organizations, each with important and demanding needs will serve their own needs first. A boss or referee is especially important because the playing field is not even; the Air Traffic Service is the big gorilla in accepting or vetoing innovation, with Flight Standards close behind.

Breaking Down the Walls between FAA's Elements

Every FAA administrator has recognized the need to break down the walls between the FAA elements (although the 'separate businesses' idea of organizing FAA would seem to point the other way).

The heads of the FAA Research & Acquisition and Air Traffic organizations have pledged to work closely to help break down the walls, but in my view it will happen effectively only if there is continuing pressure from the top to create a genuine partnership, and a tempering influence above to keep demands and requirements within realistic bounds. Even so, the decline in the number of FAA technologists and the recent loss of operational and technical depth make the task daunting - or perhaps impossible.

It is critical that the FAA operating services and their management structures are sufficiently exposed to the potential of new technologies and broader visions of the future. But it is inevitable that the FAA operating services, faced with the pressures of today, will concentrate on today's problems. Line controllers and their headquarters graduates should not be put into a position to prejudge whether such innovations will work out--until they can see, feel, and touch them.

Controllers and their labor representatives and managers must be expected to insist on the highest quality of technical support, and must have a strong role in ensuring that the systems offered them work properly. They must be, or must become, fully cognizant and educated members of the development team, but must not have a veto on innovation. It is important to recognize that air traffic controllers may have a legitimate self-interest in resisting labor-saving technology. It is up to management to overcome this resistance.

It has often been suggested that FAA R&D would be better conducted by the individual services themselves rather than by a central organization, to be sure that the specific needs are met in a timely way and under the supervision of the service that needs the product. While the idea has some merit, it probably would not serve FAA well. The individual operating services would inevitably concentrate on very near-term projects, and would neglect longer term needs. They would take a parochial approach, quite probably shunning scary innovation. A far better way, in my view, would be a close relationship between the several FAA elements to create a truly FAA-wide R&D effort, working with the user industry, and driven and coordinated by the Adminisitrator's multi-discipline system team described above.

The Need for Decision-making at the Highest Level

There is no real alternative to a presence at the highest level in FAA, the Administrator or the Deputy (or a designate at that level) to make the important calls - not by popularity contest consensus building alone, but by listening to all interests and then making the tough calls.

Examples abound which illustrate the need for top level decision-making.

> The great difficulties of the Advanced Automation System are traceable to a series of FAA Administrators not being informed and not being willing to lead.
>
> Ditto the lack of any serious move to domestic ATC automation, or even the direction it should take.
>
> Virtually the entire industry endorsed the highest-priority recommendation of the FAA R&D Plan Review Panel that "the safe achievement of additional airspace and airport system capacity be assigned as the highest priority within the FAA R,E&D activity". Yet, in the recent organizational reshuffle, the level of effort has declined, activities which need to be tightly connected seem to be more fragmented, and the FAA group formed some years ago to prod action has been de-emphasized.
>
> The inability to make decisions on the future surveillance system, the lack of decisions on data communications for ATC, the fact that MLS implementation was dragged out so long that new technology overtook it, and on and on, attest to the need for a full-time, hands-on tough decision maker for the whole FAA, not one segment or another. And it must be at the top.

It is reasonable to ask how the FAA administrator, with all the jobs and worries mentioned earlier, along with his political chores, can be expected to be that wise, technologically-savvy decision maker. After all, FAA's top management (and far down the chain) expend vast amounts of energy in developing, analyzing, and responding to one after another FAA restructuring proposal, one after another budget alternative, one after another investigation, one after another hearing.

I believe the answer is that there is no other alternative, but there are ways to help.

In several FAA administrations the administrator chose to be the "outside man (person)," and the deputy administrator, who was technically oriented or had broad FAA experience (and knew the managers and where the bodies were) was the "Inside man (person)" who ran the place and pulled separate organizations and egos together.

There may be another, perhaps a better way. A number of times in the past (if memory serves, it first offered by the Air Transport Association in the 1980's) an idea was put forward for FAA to establish a 'chief operating officer', or a 'National Airspace System director, a tough, highly qualified career executive who would be responsible directly to the administrator for the operation and the improvement of the FAA system of facilities and services. Using the system team described earlier and after consultations with the FAA organizational elements and industry, he would make the necessary

recommendations for decision and actions to the administrator.

The Bottom Line

Managing the aviation system or achieving major improvements and innovations can't be done by consensus; it must be done by strong leaders willing to get involved in the details and making decisions after consulting the interested parties.

I believe that, given the weapons which are now largely in their hands, FAA's leaders:

Can make tough decisions on system issues and people, using a deliberate system process and a dedicated small system team of 'the best and the brightest' at the Administrators's or the deputy's level,

Can insist that FAA operate as a coherent organization without veto power by one or another special interest group inside or outside FAA,

Must be willing to be highly vocal when there is not enough money to do the job or when misguided policies rob FAA of the people and the internal expertise needed to do the job, and

Because FAA's job can't be done without a dedicated corps of highly competent, fully qualified scientists, engineers and other discipline experts, FAA's leaders must have the opportunity to create an influx of new capability into FAA, and to establish a clear path to their continuing education. morella tes

Mrs. MORELLA. Thank you very much.

I want you to know, gentlemen, that as you respond to questions, I hope you'll feel free to interact with each other.

In other words, if Mr. Fearnsides thinks that Mr. Poritzky is not on target with what he said about the need for the best and the brightest, or feels that Loral isn't doing it, I hope that you'll feel free to respond that way.

But at our first hearing on FAA's acquisition management, the Office of Technology Assessment stated, and I quote: "Modernization efforts have most often been held up by inadequate understanding of operational and procedural issues, rather than by insufficient technological expertise."

The GAO—the General Accounting Office—stated, and I quote. "Other factors include the lack of mission analysis, changing requirements, inadequate operational testing, poor contractor performance, inadequate contractor oversight, and frequent turnover of FAA administrators."

That takes in a lot of elements. And I wonder if you might respond to it in terms of, in your opinion, why has ATC modernization been so chronically delayed, since it obviously is so needed?

Again, perhaps, unless any of you want to volunteer, I would start with Dr. Fearnsides.

Dr. FEARNSIDES. Thank you, Ms. Morella.

It's a complex question. I think I would disagree with the first part, which is that there are a lot of technological ideas that aren't implemented because of a failure to understand procedures and operational needs.

I think that there may be a failure to understand external operational needs. I think the needs of the internal operational personnel, the needs of the controllers and the maintenance people of the FAA are very well understood.

I think a good part of the failure to bring ideas that would improve the performance of the air traffic control system into operational use is connected to the reluctance of the operators and the maintainers to accept technology that would change, materially change, the way business is done.

In many ways, the FAA is going through what U.S. industry is going through. Let me give you a couple of examples.

AT&T, before divestiture, had a whole different way of operating its nation-wide telecommunications network than it did after divestiture.

The airlines had a whole different way of operating their operations, their system, after deregulation.

The fundamental idea of what it means to operate the air traffic control system is ingrained historically in people who don't want it to change, and I think that that's one of the really important aspects of trying to bring this new technology to bear.

Now, from the standpoint of acquisition management, a good bit of it came about from, in many ways, the FAA's large-scale, the $20 billion NAS plan, which was introduced in 1981, as you mentioned in your opening remarks, came about just before a revolution in the way systems get developed. And they just made many very large, major systems acquisitions that had to exist over a long period of time and were extremely complicated to pull off, especially given

that operational requirements and technological opportunities changed underneath during that period.

So what we've been advocating for some time is a more evolutionary approach towards system development which I think could help that—do smaller pieces, put them in chunks.

And there may be a subsequent question on the integrated product teams, but I think it's a step in the right direction to try to make that happen.

Mrs. MORELLA. Mr. Stevens?

Mr. STEVENS. Yes, Madam Chairwoman. In the conduct of my responsibilities with Loral, I've had the occasion to visit controllers in their work area in the enroute centers and in the TRACONS—the terminal approach control facilities.

From that perspective and the interaction with those folks, I did not get the sense that they were reluctant with respect to their anticipation or their acceptance of any effort to modernize or improve their work environment.

In fact, they were very much filled with questions as to how quickly we could get the technology to the field.

Most specifically, in the case of Seattle, which is the first operational site for the Display System Replacement program, they were very actively involved in an animated discussion of how they could contribute into bringing that technology to the field.

I don't think that there is any question with regard to my specific experience on the Advanced Automation System program, which I know has been the subject of discussion in the subcommittee previously, that the program experienced a considerable amount of difficulty.

With regard to program management, I think I believe in some fairly fundamental concepts and some bases.

Among them is the notion that largely the program's success is determined at the front end of the process—the degree to which the acquisition strategy is clearly articulated and the degree to which the program plan is driven to successive levels of detail and reasonably understood by all the constituents.

Insofar as there may have been a failure to do that previously, my experience with the integrated product teams, most specifically, the integrated product team that the FAA has formed to conduct activities in the enroute environment, has been one where those end-users, those folks who are working in Seattle, for example, have a voice in the design and the other aspects of the program, like the computer-human interface, such that we will no longer be in a position to go through a lengthy development and production process, only to deliver a system that the end-user would ultimately find to be not satisfactory.

Mrs. MORELLA. I know you faced a tremendous challenge in picking up the air traffic control responsibilities. And you did say also in your opening statement that you're on schedule with regard to modernization, which is encouraging.

I wondered—does Loral conduct independent R&D that could well be associated with FAA's long-term technology objectives?

Mr. STEVENS. Yes. As most businesses do, we do conduct company-funded research and development. Unlike some firms that apply a formula to determine the amount of provisioning or fund-

ing each year, we employ a more zero-based concept where each investment opportunity is judged on its individual merit, and how that project might contribute to our business plan, our strategic plan, and the strategic plan of our customers.

To that end, we regularly brief FAA senior management on the conduct of our research and development programs, specifically what they're designed to accomplish, and engage in some interactive reviews of the quality of the program.

The aim of that certainly is to make sure that we're spending our limited resources in a fashion that our customer finds productive, and conversely, would enable the FAA not to make a duplicate expenditure of funds knowing that we have already done so.

Mrs. MORELLA. Thank you. I'd like to hear from Mr. Fleming.

Mr. FLEMING. Thank you. I'd like to focus primarily on the operational requirement setting in response to that very complicated question, since airlines obviously have no direct involvement in the management process inside the FAA.

I agree with Dr. Fearnsides that FAA has a much better comprehension of the internal operational requirements and they continually are having dialogue with, for example, the air traffic controllers union about the adequacy of the system and the system's plan for the future.

In the past, the agency has not been effective in seeking out and integrating the needs of the system users, the airlines general aviation, for example, into their planning process.

And in fact, ever since the advent of the Boeing 757, 767 family of airplanes, the airplanes have capabilities which far exceed those of the air traffic control system in certain respects. And we are only now beginning to be able to take full advantage of those capabilities.

Having said that, again, I would turn to the task force three report recommendations, which are very heavily operational in nature, especially at the front time. They're time-phased.

The phase one recommendations primarily relate to objectives which can be achieved through largely procedural means, without significant investment in new capital-intensive programs.

The far-term objectives are capital-intensive and require a great deal of development work and research work.

In between is the mid-term.

I think that again provides a basis for planning together. Airlines are not going to implement new capabilities in airplanes without assurance that the FAA is going to do their part on the ground.

We've been burned too many times. It isn't going to happen again.

Now, FAA can provide excellent incentives. Let me give you one example.

This year, the Air Traffic Service has expanded what they identify as the national route program. This authorizes suitably equipped aircraft to fly direct routings, the most efficient routings between two terminals.

You can't take off from Dulles and fly direct to Seattle, but you can depart from the Washington terminal area and arrive at a fix perhaps 150 miles from Seattle.

They have now authorized such clearances down to 33,000 feet. This is a very valuable capability.

Now the airplanes that are equipped to fly are those that have flight management systems, and again, those tend to be the airplanes I already identified—757, 767 and later.

What we're now seeing is a rush by airlines to equip older airplane types with that kind of area navigation capability using GPS, the newest technology available to us. That is the cheapest, easiest way to get that area navigational capability that would enable those old 727s, 737s, and DC-9s to participate in the national route program.

That's a perfect example of what we need to do to make progress.

Thank you.

Mrs. MORELLA. That ties in to what I was going to ask you about the specific examples of situations which need that sense of urgency that you mentioned and the kind of continuity.

You may want to at some other point elaborate on that, too.

Mr. FLEMING. Well, I might elaborate just a small bit right here.

That impetus came from the operating service, the Air Traffic Service in this case. It was not dependent on any new capability in the facilities.

To get to the free flight objective as described in that RTCA report is going to require capabilities beyond what Loral and the other FAA contractors are planning to implement in the current acquisition programs.

However, I believe their systems architecture is sufficiently open so that we will be able to find ways, FAA will be able to find ways to implement those needed capabilities.

Mrs. MORELLA. Thank you. Mr. Poritzky?

Mr. PORITZKY. I'd like to agree with Dr. Fearnsides on much of what he said in response.

I think the idea that we don't know what operational requirements are is a canard. I think we know perfectly well what operational requirements are. And if anyone is in doubt, the airlines have done a very good job of telling FAA what they think they need. So has general aviation, over and over again. So has the airport community.

That's not the problem.

The problem, I think, is, as Jack said, is in the transition of innovative technology into the system.

The Air Traffic Service has been reluctant, as he said, to accept innovation. I think that's where the problem is. That is precisely why, in my opening comments, I said the decisions on what will be done must not be made by any one element.

The Air Traffic Service is the largest and, in a sense, the most hierarchical part of FAA. And the reason for the system design team recommendation, the reason for this decision-making process needs to be at the level of the administrator is precisely to overcome that problem.

I'll cite an example, also.

The forerunner of the Advanced Automation System, some level of automation en route to do the kinds of things that Roger Fleming has just talked about, was initiated in 1974. It doesn't exist.

It failed again with the problems with the Advanced Automation System that we've all heard about.

The terminal automation work was begun in the '60s. It's still not implemented anywhere.

And the reason is not that it's rocket science. It's a tough problem, but it's not rocket science. It is predominantly a willingness to innovate and to take the small steps that Dr. Fearnsides talked about.

Thank you.

Mrs. MORELLA. I can see the importance of following through after this hearing that we have, too, in terms of trying to craft, maybe crafting legislation that will address some of the problems we've already heard.

I am going to now turn the chairmanship of this meeting over to my colleague, Todd Tiahrt, from Kansas, while I go across the street to Longworth to testify on my bill, and I shall return.

He will do it very adequately.

Mr. TIAHRT. Thank you, Madam Chairwoman. I have you all to myself for some period of time here.

I would like to start with Mr. Stevens and talk a little bit about where you're at in the process of the automated air traffic control.

I'd like to know where you're at in your schedule, completion dates in the future. And at the risk of sounding unknowledgeable of what you're doing, I want to find out where you're at in the process and when you anticipate being on line, or what percentage on line, or some kind of a yardstick so that I know where you're at in your process.

Mr. STEVENS. I'll see if I can set up a framework for you this morning so you can get a sense of the progress we've made.

I suspect that the center of your question is the progress associated with the Display System Replacement, which is the largest part and continuation of the restructured Advanced Automation System program.

If I look backwards in time for a moment, I've been with air traffic control with Loral for about two years. I joined the air traffic control division at a time during Loral's acquisition of federal systems from IBM, and at a time when the Advanced Automation System was being reported as having two rather large slips to the schedule—a 14-month and a 19-month slip.

So it was 33 months down to roughly a 60-month elapsed schedule time, with projections of another 12- to 18-month slip.

So by a schedule measure, then, the program had earned about one week for every month that the program had been running, certainly not——

Mr. TIAHRT. If I can interrupt.

Mr. STEVENS. Surely.

Mr. TIAHRT [presiding]. The first slip that occurred, and the second slip, what part of the requirements had been written? They were in systems development? Or what part of the process were they at when the slips occurred?

Mr. STEVENS. I believe those—not having been directly involved, I believe those slips occurred after the initial concept exploration and design development activity had concluded.

I believe that was an effort from about 1982 to 1988. This was after the award through a competition of the production and deployment contract.

As you know, the Advanced Automation System was a very broad, large program, an effort to modernize a number of the segments, enroute, terminal, and tower simultaneously.

This was after the production deployment award of that contract, I believe. The first slip occurred perhaps two years after that, maybe around 1990. And the second slip perhaps reported a year or so later.

Again, my first look at the contract had indicated a 36- to 48-month slip over 60 months running and it was not making good progress, to say the least.

With respect to the dollars associated with that, it appeared at the time that, based on a progressive series of increasing cost estimates, that for every dollar estimated for the original completion, the program was perhaps requiring $1.70 or more.

We, after Loral's acquisition of the company and the program from IBM, set about a restructuring with, I believe, the first integrated product team established in the FAA to restructure the enroute segment and specifically address the Advanced Automation System program.

We had a contract schedule baseline and performance baseline that was negotiated over several months in 1994, effective the 4th of October, 1994.

Compared to that schedule and that cost estimate that was negotiated in the restructuring of the Display System Replacement program, we are absolutely on schedule after 14 months of performance, which, I think, when contrasted to the degree of difficulty experienced in accomplishing prior schedules, is a marked improvement. And we are favorably performing to our estimated cost targets by about $9 million today, over that same span of 14 months.

During that period of time, in conjunction with the integrated product team from the FAA, we revalidated and re-established a complete requirements baseline. And that is working in conjunction with the integrated product team. And that did include the involvement of those individuals who would have to in fact use the system and maintain the system once it was fielded.

That is a very complete and elaborate process. There are more than 4,200 specific requirements involved in the performance of just the Display System Replacement program.

Each of those requirements was mapped, then, to a specification set. There is a series of gates that we established with the FAA in the review of the program to assure that the specifications that were written in fact reflected all of those 4200 requirements.

Those specifications have all been flowed down to a successively lower-level tier structure to assure that all the subproducts or subcomponents of the system, once they're designed and developed, will perform consistent with the specification to meet that requirement.

And in November, we completed a major software drop which concludes, or nearly concludes, our software development or code-writing process. We have turned that over to a systems integration

process, which is the next step in the sequence of delivering the hardware.

So, with the exception of being 13 days down to performance against the critical design review, which was a review in September, and I think it's noteworthy to note that we could tell we were 13 days down, where previously on this program, measuring in days was not one of the conditions prevalent.

We are on schedule today with the software development. We will take that software drop through a series of integration tests, both in our Rockville facility and we'll transfer the testing regimen to the tech center in Atlantic City, between now and March of 1997, where the FAA is planned to accept the hardware and software baseline at the tech center after having it fully tested, both through a series of what are known as informal dry runs, dry runs, and then runs for record, to assure that the system performs.

After it's accepted in March, it goes through a series of follow-on tests, operational tests and evaluation.

That should result in a completion of the operational tests and evaluation in July of 1997. We then move the system to Seattle, which is the first installation site. That should take place in August of '97. And then it goes through a series of tests in Seattle to assure that the site is properly integrated and that the system can be tested in its operational environment.

Mr. TIAHRT. Is this at CTAC? Or which air field is it at in Seattle?

Mr. STEVENS. I'm sorry. That's a Seattle enroute center. It's not affiliated with a specific airport.

That should occur in January of 1998. We will have an initial operational capability review and sell-off in June of 1998, and the system should be operational in October of 1998.

So looking backwards, at least over the last 14 months, we have performed precisely on the targets that we have established, making all the major milestones, and we don't foresee any difficulty in making the milestones that are yet ahead of us.

I think it's of interest to the Subcommittee this morning that, to be candid, we don't believe that it is enough to make the program milestones that are laid out before us.

And that's a view shared by the members of the integrated product team represented by the FAA. We are now looking at ways, exploiting a notion that's pretty popular in business, known as continuous process improvement.

We have a schedule. We're trying to find ways to improve upon that schedule because we know that delivering this operational capability is absolutely vital.

For example, we've completed ahead of schedule the Seattle site survey. Now it may be a small milestone. But we're accelerating activities to accelerate our ability to deliver hardware and software to the site earlier, so that the users can get more involved with the activity that's associated with bedding down a new system, with the intention of trying to pull forward as much as possible all of the critical and noncritical events to assure that we at least hold our schedule that we're on today and, if possible, improve that schedule.

Mr. TIAHRT. In your CDR, which was last September, you said.

Mr. STEVENS. Yes.

Mr. TIAHRT. Are there remaining open action items, or was it set of signed minutes afterwards?

Do you have a baseline established now for your configuration?

Mr. STEVENS. Yes, we in fact do, and that's an important difference that we've imposed on the program.

There is no possibility now of proceeding with the next sequential stage of the program without completing entirely the prior stage necessary by virtue of exit and entry criteria that we've developed with the FAA, have formalized and imposed so that the members of the team can stop the process, can stop the software delivery.

And in fact, this has happened. For example, if the documentation, if it's necessary to accompany the code, isn't in a form and fashion that is sufficiently complete or adequate to support that code, that process stops.

And there are members of the team, and it's an interesting manifestation to watch the change in the character of the team when a person who is a quality assurance representative can stop the delivery of the software.

It's part of the cultural change we're infusing and I believe the FAA is also infusing.

So we have very clear exit and entry criteria that must be completed. The baseline is formalized. It's documented. There are not open issues that are yet to be resolved. It's been closed out with the FAA.

Mr. TIAHRT. Well, how do you adapt configuration changes coming out of your continuous improvement process?

Do you do it through a class one change to your baseline? Or how do you document your changes because you're going to come up with some obvious improvements, or hopefully. Otherwise, you're wasting your time with your CDR.

Mr. STEVENS. I don't remember who on the panel here this morning made the comment about the emerging requirements and perhaps an overreaching view and trying to grab everything into the program and do it all at once and thereby, never in fact delivering anything due to this churn of the baseline.

We've advocated a long-standing concept known as pre-planned product improvement. It's called P cubed I.

Irrespective of what it's called, the thinking underneath it is very clear, and that is, we work at the front end of the program to develop an adequate program plan and acquisition strategy, including the interests of the end-users and the maintainers so that the baseline program can be delivered and used as it's designed and developed.

And then, in a parallel course, using the type one change process that you described, we accumulate the kinds of changes, and most of them are not mission-critical because if the thoughtful planning goes into the program at the front end, you don't have great omissions in the mission-critical requirements, we accumulate those issues or items that may need to be changed and infuse them or insert them into the program at a pre-planned time, such that it is not disruptive to the continuing process of delivering the baseline technology to the field.

That's one of those management areas where it is also our view that it's not the far-reaching technology that's been the obstruction to getting the system to the field, it's the management of issues like this change process.

Mr. TIAHRT. You're integrating your software into a baseline system, or some type of system? You said you're going through an integration process.

Is it existing hardware or are you changing the hardware? I assume you're changing some of the hardware, too.

Mr. STEVENS. The hardware baseline is pretty much established with the initial sector suite system which was the fundamental design from which DSR was lifted.

There have been very little hardware changes. Some of it's been simplified. The console has been changed slightly. But there are no major or significant hardware redesigns.

Mr. TIAHRT. Tell me what the make-up of one of the IPTs—how many IPTs do you have on the project?

Mr. STEVENS. Well, the way we are organized and, in fact, within Loral, and internal to our operations, we think highly enough of the benefits of integrated product teams that we are in fact organized around integrated product teams.

So insofar as our organization meshes pretty well with the FAA's organization by the nature of these designs, it in fact does so.

The areas that we're most involved with are the enroute segment, the terminal segment, and the tower segment. The FAA is organized around product lines in a similar fashion so that each of those segments has an individual integrated product team.

So we're active primarily with three of what I understand to be 14 integrated product teams.

Mr. TIAHRT. Three groups of 14 integrated product teams?

Mr. STEVENS. No. We are active with three of what I believe to be a total of 14.

Mr. TIAHRT. Okay.

Mr. STEVENS. One called the enroute integrated product team, the terminal integrated product team, and the tower.

Mr. TIAHRT. Your integrated product team is at the top tier, it involves members of the FAA.

Is that true?

Mr. STEVENS. Yes. It is the FAA's integrated product team.

Mr. TIAHRT. That you participate in?

Mr. STEVENS. Yes, we believe we are card-carrying members of that product team.

Mr. TIAHRT. Well, as I understand it, you're the systems integrator, though, on the program now.

Mr. STEVENS. That's correct.

Mr. TIAHRT. Is FAA managing it or are you managing it?

Mr. STEVENS. FAA provides oversight. We're the contractor to provide the systems integration activity.

So I don't want to confuse the systems integration activities or systems design activities of DSR with the NAS architecture that is resident in the FAA.

Mr. TIAHRT. Well, if you're integrating, you're past design now.

Mr. STEVENS. Yes, we are.

Mr. TIAHRT. You've got your CDR. You've got your baseline.

Mr. STEVENS. Yes, we do.

Mr. TIAHRT. Well, how do you interface, then, with the FAA?

Mr. STEVENS. Certainly, on a formalized basis, with regular monthly program reviews as a minimum.

But the way the integrated product teams have worked has been interactive and, in fact, on a daily basis. And I would submit to you that with the amount of effort that went into restructuring the Advanced Automation System to draw out the DSR design, it would not have worked at all if we didn't have a very interactive regular interface with the members of the integrated product team with the FAA.

We simply couldn't have gotten it done.

Mr. TIAHRT. Dr. Fearnsides, I've been to your MITRE facility in the Boston area. I think you do fine work, a wonderful thinktank.

I occasionally come in—I've worked with some of your members before in the past—my previous life, I should say.

Dr. FEARNSIDES. Wonderful.

Mr. TIAHRT. Do you operate inside MITRE with IPTs? The concept is not new. It's been going on for some time.

Let me preface this by saying that I know that some of your members have participated in IPTs. But do you operate the MITRE corporation that way?

Dr. FEARNSIDES. We are not lined up specifically, organizationally, with the FAA's integrated product teams.

However, as a matter of fact, a good bit of our work has to do with how to deal with the cross-cutting issues that go across the IPTs.

However, in order to be able to understand those programs in sufficient specifics, we do have—we are members of just about every substantial IPT that the FAA has, but with very small numbers, as compared to, say, with what Loral might have.

We're more involved in the architecture issues, in the cross-cutting issues, in the technological development issues.

For example, with the creation of integrated product teams, research and development was taken from a separate organization and put into the integrated product team so that each one of these teams could manage the entire life cycle from R&D to fielding.

And as my testimony indicates, we have an extreme interest in taking things from concept to completion and we are a constant advocate for expediting technology through this process.

So since we're primarily a research and development organization, as opposed to a system integrator or a system developer in the way that Loral is, we have a tendency to participate more in the front-end work of the IPTs, but to constantly work with the operational folks to try to get that technology substantiated into the operational system.

Mr. TIAHRT. You spoke about an evolutionary approach to systems development.

I think technology, when you have a large system, you have kind of a quantum leap in technology and then you start chipping away at it or making changes to it, slowly progressing, try to improve it. Then you make another leap.

And I think we're in that process with our air traffic controls. We're making that leap into this new technology, GPS, as Mr. Fleming described.

But we're already starting the process of changing it. Any time you have a continuous improvement process, you're going to see changes come along in the baseline.

Can an IPT aid in the process of system management inside the FAA as we go through this improvement, continuous improvement?

Dr. FEARNSIDES. I think it can, and I think that the basic idea is a good one.

I think what's happened is that the concept and the processes that support that concept are not yet matched. The concept of evolutionary system development is just another way of saying what Mr. Stevens called P cubed I, or pre-planned product improvement.

The idea is a continuous improvement process and changing the applications, the things that would improve the performance of the air traffic control system while you're changing the basic infrastructure of the system because there's a constant need to move forward. This is the architectural kind of idea that Mr. Fleming has referred to.

But the problem is that all of the processes in the Federal Government, and including the Congress, have not yet caught up with the idea of evolutionary system development.

The DoD has recently introduced a concept called managed evolutionary development which would take their oversight, and understand that there are different kinds of developments—those that will evolve continuously and those that will be kind of big steps. If you have to buy a new radar, for example, there's almost not a way of continuously improving the actual hardware of the radar, although you could certainly improve the software.

So what we need to do in the FAA is two things, and we're all working very hard to accomplish this cultural transition, as it were, from a major system acquisition approach to a managed evolutionary development one. And we've got to instantiate the processes that support that transition. We've got to make sure that people understand them, that the review councils inside the FAA know how to know programs are doing well. And the same is true in the office of the Secretary of Transportation. And the same thing is true in the Congress.

It's very simple, a lot simpler to think about critical design reviews and the kind of things that Mr. Stevens talked about, than it is to really understand when the executive branch and legislative branch oversight mechanisms are going to really interact with that.

I think the second thing that's really important to make this happen is to bring the FAA's system architecture function at a point where both Mr. Fleming and Mr. Poritzky have made, more into being.

The thing is that the way of managing an evolutionary system development has a great deal to do with understanding the architecture and how to evolve that architecture and how to evolve it towards a goal, not just a step at a time.

So instead of, for example, thinking about—the operators of a system have a tendency to think about what they're going to do to-

morrow to the system. The technologists have a tendency to think about what they're going to do in 20 years to the system.

What this system requires is kind of thinking like a chess game, where you're taking individual steps, but thinking two or three steps ahead.

And we've got to get our processes together so that we understand how to do that and we've got to integrate the system architecture function of the FAA more closely with the IPTs.

Mr. TIAHRT. And when you say change the processes, I know that you're addressing documentation.

And after living through one revision of the federal acquisition regulations, where we went from a 4,000-page document, revised it, and it then became a 1,500-page document with 6,000 addendums.

Dr. FEARNSIDES. Right.

Mr. TIAHRT. 6,000 pages of addendums. So we actually grew.

Dr. FEARNSIDES. Right. As a matter of fact, getting back to one of the fundamental premises of these hearings, there are a lot of experts in Washington on the acquisition process. And there are a lot of people who want to tune that process in a way that makes what has become a big, clumsy system into something that's better.

What we're talking about here, to take a point that you made a little bit earlier, Mr. Tiahrt, is a paradigm shift. We're really literally saying, you can't tinker too much with that acquisition process any more. You've got to move to a new way of doing business.

And that takes time.

There's a famous book by Thomas Kuhn on the fundamental scientific revolution and the changes that are required to go from one to the other.

And all of those things are happening now. We have the ideas. We're trying to struggle through to the new paradigm. Some people have gotten the idea. Some people don't have the idea yet. And what we're trying to do is transform it into something that everybody understands and can deal with.

It's a tough job.

Mr. TIAHRT. I think it does take a while to bring a change about, especially—well, even in a corporation. But when you address government—I know for the last 11 months, we've seen great resistance to change and we'll probably continue to see resistance to change.

Mister—is it Poritzky? I'm interested in knowing if you think that this type of a systems management team concept would be adaptable to the FAA.

Do you think they can work in teams? It's probably more easy during the research and development phases of various programs for the hundreds of millions they spend on R&D.

But the administration process managing the overall system, once it's in place, I'm interested in your thoughts about that.

Mr. PORITZKY. I believe that Mr. Stevens in a way gave us the answer. He talked about the remnants of the Advanced Automation System which Loral is now trying to bring to reality.

He answered a question by saying that he's working with three integrated product teams.

The integrated product team idea, in my view, is a very good one, as long as there is an overriding activity in FAA which deals with the larger system and the system decisions.

To separate the terminal automation system from the en-route automation system is kind of funny. Certainly, every operator wants to assure that there is a seamless transition from the en-route system to the terminal system.

The way to make that connection happen is by what I believe is a system design team, as I've said in the statement, a team of the best and the brightest, and they cannot be anywhere either in the acquisition—serve the research and acquisition organization, nor certainly in the air traffic organization, nor in the flight standards organization.

They have to work very closely together.

But if they are going to work together, there has to be something above at the administrator's level to make it happen.

Now I think that it can be done. There was one or two cases in FAA's history in which it was done and was done to very good effect. I think without it, we're doomed to continue to flounder. And let me just cite an an example again in the Advanced Automation System.

There are many theories as to why the Advanced Automation System program failed. One of the most interesting ones to me was that there was a continuous set of changes of the requirements imposed by the Air Traffic Service on the engineering side of the house.

The way it was dealt with was by continually reducing the capabilities that that system was going to come out with—it didn't—but it was going to come out with. And of course by raising the cost and delaying the implementation.

The argument, and the then-acting administrator testified to this a year and a half ago, was that there was no one at the top willing to knock heads together and say, we're not going to keep changing the requirements.

I believe that has to be done by this overarching group of people who advise the administrator, because only he can finally deal with it. But I think that's where the requirement is. I think it can be done. I think it takes a lot of will. It's very tough. But I think it can be done.

Mr. TIAHRT. Thank you. I have probably gone beyond my allotted time. But as a freshman here in Congress, I've enjoyed it greatly.

I have other questions, but I want to recognize the Ranking Minority Member, Mr. Brown, who, historically, has a great deal of not only number of years of accumulated knowledge in science, but also in quality of thinking for the Science Committee.

And so I would like to turn it over to Mr. Brown for any questions that he would have.

Mr. BROWN of California. Thank you very much, both for your kind remarks and for the excellence of the job that you've been doing with your own questions, which I have found to be extremely useful to me.

I apologize because I was not here in time to hear the oral testimony. I wish I had been, and I'll make my questions, accordingly, somewhat briefer.

Let me first thank Mr. Fleming, who, in his written testimony, which I glanced at briefly, paid tribute to the analysis that the OTA made in the May hearing. And as a long-standing member of OTA's board, and occasional chairman, I was very pleased to hear that, although it came a little too late to help save the organization, unfortunately.

I am concerned about the general problem that faces us as we move toward a superior system of air traffic control, which we've been working on, as we all know, for many, many years, and the technology has been changing during all those many, many years.

I'd like to have a feeling—and I confess that I'm out of touch as to whether or not this current state of technology is likely to remain stable enough to allow us to complete the planned system without further radical change or delay.

And I know this is a simple-minded question, but could I get a comment from one or two of you about that?

Dr. FEARNSIDES. Mr. Brown, first of all, let me tell you that the only good thing that probably came about from the dissolution of OTA is that we got two of the stars hired in our Center for Advanced Aviation System Development.

We're very pleased to have them.

I don't think the problem is a technological problem any more. I think the technology is there. I think there is the business of what I know you know is called technology insertion, and how to take that technology and put it into what is obviously a very complex technological and operational system and do that in a way that doesn't disrupt the operation of a system that is so critical for us.

And I think that we can take lessons from two examples that I mentioned earlier, which is how organizations like AT&T or MCI developed to insert technology into their complex system after divestiture, and how the airlines have had to do the same thing to stay competitive after deregulation.

Those two are extremely important examples to try to model as we think about how we want to move forward and get that needed technology, not only to upgrade the infrastructure of the air traffic control system, which has been the dominant aspect of the FAA's investments over the last 20 years, but also to make really important, needed system performance improvements, the actual performance improvements that are envisioned by the RTCA task force three report that I think as a community we all have to rally around and figure out how to implement.

What we don't need in many of these things is a lot more research or a lot more technology, so much as we need ways to figure out how to insert it into a complex system.

Mr. BROWN of California. Anyone else want to make a brief comment on that because I'm not trying to belabor this point?

Okay.

Mr. FLEMING. Perhaps I can give you a specific example that will illustrate our ability to do that in a very narrow context.

One of the first actions that Loral took in the Rockville facility was to establish what we called a technology insertion laboratory and set it up on our own.

Because, if I understand the essence of your question, as the technology changes rapidly, in our view, the hardware technology, the processing speed and capability is changing at a rate faster than certainly the development of software capability.

One of the things that we wanted to demonstrate to ourselves and then subsequently to the FAA, was that in fact the code that's being written for the operational system for the Display System Replacement program could in fact run on alternative processors, not just the processor which is a commercially available box, but not just on that process, but run on a family of processors beyond that.

And we have demonstrated that to ourselves and to the satisfaction of the FAA.

So I think much of it has to do with an architecture that enables a reasonably straightforward insertion of advanced, say, hardware technologies that run on the same software or software with little modification.

Mr. BROWN of California. Well, let me cut this off briefly. I wanted to ask Dr. Fearnsides just one question.

You indicated that there was a potential for the duplication of research, I gather between NASA and FAA. And I wanted to ask you if you could comment on that briefly and make reference to any specific programs that you thought might possibly have that potential for duplication.

That's one thing our committee oversight ought to be focusing on in any of the agencies that we deal with. It may be the most useful thing that we could perform.

Dr. FEARNSIDES. Thank you, Mr. Brown.

NASA has come forward with a new program, a new initiative, and has established a memorandum of understanding with the FAA for a joint R&D program.

I think it's an important addition. I think, especially given the cutback in the FAA's R&D budget in these days, having people of the skill and ability of, say, the Ames Research Center, is crucial.

I think what we need to worry about are two things.

First of all, whether or not systems that were developed, for example, as—I can't remember whether it was Mr. Fleming or Mr. Poritzky made the point about there being an artificial distinction between terminal and en-route air traffic control these days.

Well, there are systems that say that we might have been developed doing en-route control and systems that NASA might be developing for terminal control that, as you think about the way the air space management functions are developing, will have a tendency to have duplicate functions.

I think having a system architecture and making some of those decisions that need to be made is a very important thing.

That's point one.

Point two is that I think it's really important—one of the major arguments of those of us who participated in RTCA task force three pushed, it's really important not to reinvent technology that's there and may be ready to go to the field in the interest of research.

The FAA has established procedures to begin thinking about how they allocate these research functions. But I think we need to keep pushing to make sure that there is a good resolution of this and that there's not a whole period of time where we spend a lot of time

arguing over one system is better than the other and keeping those research products from getting to the field.

Mr. BROWN of California. Yes?

Mr. PORITZKY. May I add just a word or two?

Some years ago, I was in FAA and was responsible for coordinating the relationships between FAA and NASA for Administrator Helms.

There was—at least in my experience, there has never been much of a difference of opinion between the administrators of NASA and FAA on the desirability of their working together.

I think there has also been a turf problem lower down in the organizations. And one of the reasons that I harp so much on the importance of the capabilities in FAA, the technical capabilities, the technical level, is that, in my experience, people in FAA who are themselves capable, who are able to deal appropriately with their counterparts at NASA, find ways to use NASA and to work with NASA very effectively.

When you find people in FAA who are inadequately trained, who are not technologists at the same level, you will discover that the work doesn't flow. It just doesn't happen. They can't afford to let NASA or somebody else help them.

And I think that's a very critical point in saying that we need to improve the number and the technological capability of FAA staff.

Mr. BROWN of California. Can this Committee look into that kind of question effectively, do you think?

Mr. PORITZKY. I didn't hear what you said.

Mr. BROWN of California. Can this Committee, this Subcommittee, look into that kind of question effectively, or is it too sophisticated or esoteric for us to do much about?

Mr. PORITZKY. Oh, I think it could easily.

Mr. BROWN of California. Let me conclude with one nostalgia comment.

Some of you may remember that there was an old gentleman who was a lobbyist here on the Hill for many, many years, beginning 20-odd years ago, and he's long since retired. He was calling for a system of free flight controlled by satellite systems at least 20 years ago. And nothing ever happened from it while he was alive.

I think he's long since retired, and he may be dead by now. But he'd be very happy to see the progress that's being made.

Any of you remember that gentleman?

[No response.]

No. You're too young.

[Laughter.]

Mrs. MORELLA [presiding]. Thank you, Mr. Brown.

In fact, this Subcommittee is hoping to be able to craft some legislation for the next session that's going to incorporate some of the comments that were made about management, along with the reauthorization.

So we appreciate your questioning and the responses.

I wanted to turn to our distinguished Congresswoman Johnson from the great state of Texas.

Ms. JOHNSON of Texas. Thank you very much. Thank you, Madam Chairwoman, for setting these hearings, and I apologize for not getting here earlier. These schedules are getting tighter.

I am very interested in research and development and have a very personal reason, since I have most of DFW airport in my district, and four other airports. And in the minds of the people at home, any time there's an accident, they never ever forget it.

And I was looking here where the R&D activities within both the research, engineering and development account, and the facilities and equipment account, FAA provides five times as much support for R&D related to air traffic control systems from the F&E account as from the R&D account.

And the 1994 GAO report reports that $550 million of R&D was included under F&E, while the research, engineering, and development total was $250 million.

And the Fiscal Year '96 appropriations for the research, engineering and development account was 28 percent below the Fiscal Year '95. That is, $73.5 million, reduced from '95.

A review of FAA's research, engineering and development program from an outside advisory committee in 1993 had as a recommendation for the primary funding, the statement on the primary funding was not adequate to deal with increasing demands of the nation's air traffic management systems.

Does that still remain true?

Dr. FEARNSIDES. I'd like to address what I think may be two questions in your question.

The first, and I think this is very important, Madam Chairwoman, even in the legislation that you're thinking about, is that sometimes congressional direction, like system development, needs some continuous product improvement.

I think an interesting byproduct of some of the legislation that came out of this Committee eight, ten years ago, by putting a lot more emphasis on human factors—wing-icing, aircraft safety, those kinds of things, which are of course extremely important things—connected with the caps, the limited research funding that the FAA has, forced a good bit of what is called air traffic control research into the F&E budget.

That may not be a bad thing. But it does change the focus away from what this Committee might perceive as its purview, which is the R&D budget, versus what is actually happening.

Now with the IPTs—the integrated product teams—and the research being conducted inside those integrated product teams, there may very well be a good reason for having some F&E funding for air traffic control research. And, as a matter of fact, if you think about this continuous life cycle improvement, that may actually be a better approach.

But it's an important consideration for this Committee as to its oversight over air traffic control research, since a good bit of what's there is actually what might be considered more aeronautical research and maybe things that NASA has a keen capability in.

So the second point about the adequacy of the R&D funding for FAA, I think three of us here participated in the Augustine committee and we did not—I think we all agreed, both that there needed to be more R&D funding for the FAA, and that more of that

ought to be focused towards streamlining or improving the performance of the air traffic control system itself—increased capacity, reduced delays, better economic performance of the system for the users of the system.

I think at least I still agree with those. I've submitted to Mr. Corley for the record some testimony that I gave about a year and a half before the Senate Appropriations Committee that outlined some of those ideas and where that money may need to be spent.

Ms. JOHNSON of Texas. Thank you.

Mr. PORITZKY. Now let me add just a little something to what Jack said. And let me just quote from the statement that I offered for the record.

And it has to do with the question of capacity, achieving more airport system, airspace system capacity.

Virtually the entire industry endorsed the highest priority recommendation of the FAA R&D Plan Review Panel that the safe achievement of additional air space and airport system capacity be assigned as the highest priority within the FAA RE&D activity.

Yet, in the recent R&D organizational shuffle—and this is one of the negatives of the Integrated Product Teams, I believe—the level of effort has declined, activities which need to be tightly connected seem to be more fragmented, and the FAA group formed some years ago to prod action on system and airport capacity has been de-emphasized.

Again, it's a question of what emphasis do you want to provide?

I think there's no doubt that additional funds would help a great deal. In my estimation, this is probably sacrilege. I think money is probably not the most important part of this. And we all know that FAA will have to do with less, like all the other government agencies will have to do with less.

Yet, I think there's one other example, perhaps.

As I mentioned, I was formerly with the Airports Council. And one of the things, perhaps the highest priority item that they talked about is airport pavement research, which is not very glamorous. Nobody likes concrete and asphalt much. And yet, we haven't gotten good data on pavement strength and design methodology for probably 25 to 30 years.

A strong effort, with the help of several Members of Congress, has started in FAA to improve the pavement design methodology and it takes some money to do that. That has fallen out of the budget, so that certainly, from that perspective, from the airport's perspective, and it was supported by almost everybody in the industry for a variety of reasons, including our capability to sell new large airplanes in the future, that item, not glamorous, needs to be there and isn't there.

And clearly, that's part of the funding issue as well.

Ms. JOHNSON of Texas. Thank you.

Yes?

Mr. FLEMING. Thank you, Ms. Johnson.

Earlier in your comments, you expressed concern about the risk of accident which you hear about from your constituents, and it's a concern to all of us in this business, of course.

I agree with Mr. Poritzky that money is not necessarily the only problem.

Yes, it's very clear that FAA could benefit from more funding in their research, engineering and development account. But I suspect that that possibility is not very good, given the situation we're looking at through 2002.

Having said that, I am firmly of the opinion that the most important thing FAA has to do is direct its resources to the highest priority programs. And in that context, and taking into account your concern about safety, I noted in my testimony that an excellent test of application of resources in the safety arena can be found in Secretary Pena and Administrator Hinson's aviation safety action plan, which in fact is being revised yesterday and today at a meeting in New Orleans.

And I would suggest that perhaps you might want to give consideration to utilizing the product of that update session in New Orleans, which I think will be concluded this afternoon, as a test for how the FAA and NASA's resources are being applied.

Ms. JOHNSON of Texas. Thank you.

Mr. STEVENS. I don't know that I can add much to the discussion about the expenditures of the R&D funds.

The programs for which I'm responsible are almost entirely funded from the F&E accounts. We have no, what I would describe as basic research underway in support of those programs. And the development efforts that we have are largely confined to proof of concept configurations to enable us to proceed with the design and development of production systems for their deployment.

So we're involved very little in the specific use of R&D funds.

Ms. JOHNSON of Texas. Thank you very much.

Thank you, Madam Chairwoman.

Mrs. MORELLA. I want to thank you. It seems like what I've heard in response to that last question was that, even though more money would be good, and it's certainly going to be utilized well.

But the point is that lack of funds or how funds are allocated has really not been the impediment. But, rather, it is more internal lack of management and utilization of what is there.

Is that basically the case? You can kind of nod if you want, unless anybody wants to add anything to it.

Mr. Fleming?

Mr. FLEMING. I certainly agree with you, Madam Chairwoman.

I think one of the largest things for an R&D manager to do is terminate projects which are not going to be successful. And that's exactly what they need, is a tough, ruthless manager in this environment, focused on where the best results will be produced for the public.

Mrs. MORELLA. You know, early on in the opening statements, Mr. Poritzky talked about strong management and having a team that was there.

I don't know that I truly heard you all react to that. Is that something that we should explore further? When I realize the administrator is there for a period of time and then it is replaced and new ideas and you have to learn all over again, and that some firm decisions perhaps need to be made that have not been made, to get rid of some of the old, go into the new, et cetera.

I think Mr. Fleming is anxious to respond.

Mr. FLEMING. Thank you. You have touched upon a subject that is near and dear to my heart.

The only truly productive programs that I have been involved with in my 30 years at ATA have been those which involve partnership with FAA and other interested entities, and obviously, the entities would change, depending on the project at hand.

One of the major impediments that I find with the FAA, and it has become more of an impediment in the last five years or so, is the agency's interpretation and application of the Federal Advisory Committee Act.

It appears that the interpretations that have been advocated by the office of the chief counsel of the FAA have been so restrictive, that many FAA managers are loathe to involve any subset of the industry or the general public in discussions about any specific subject, unless it can be done under the umbrella of a federal advisory committee act.

Now, there is one which was in fact mandated by legislation introduced by this Committee. It includes, I think, only one or two representatives from the airline industry, and you are not going to get the collective opinion of the airline industry with one or two individuals.

You've got to find a different mechanism.

I think that the Federal Advisory Committee Act has become a significant impediment to the FAA. They have difficulty putting together a small group of legitimate experts to work a particular problem.

And in my experience, it usually takes about ten people to move something forward. And if there are many more than ten, it won't go anywhere.

Thank you.

Dr. FEARNSIDES. May I react?

Mrs. MORELLA. Yes, Mr. Fearnsides.

Dr. FEARNSIDES. I think that, to get back to Mr. Poritzky's point, the notion of having a team of people who understand the system and who help guide the system is a very good one.

I think that it needs two things. First of all, it needs a top-down look at the system and where it's going and a guiding mechanism which in technical terms we would think of as an architecture. But it also needs a decision process.

The FAA is a magnificent organization in so many ways. But the decision process has become out of date and has evolved into kind of a consensus culture that doesn't lead to swift and quick decisions.

So I think that the question of how such a team would be independent both of the technology and operational side from the standpoint of objectivity, but also be able to incorporate their inputs and provide first-class advice to the administrator, is very important.

I spent a good bit of time yesterday with Dr. Donahue talking about the entire requirements process, which is wrapped up into this, the issue of how you decide what requirements you want to meet and how you make your investments to meet them.

We have to do something in those areas.

Mr. PORITZKY. May I go back to your earlier question about the decision on where the R&D funds should be expended?

One of the problems that I think we've all observed is that we have a problem with an issue of the month, or certainly issue of the year.

When, God forbid, we have an accident which involves ice, the emphasis on research and development on ice goes up, strangely enough.

Similarly, when the skin of an airplane comes off, suddenly, there is a major push.

It's very difficult for an administrator to say, yes, we've had the accident, but I really need to spend the money on capacity or pavement or what have you. And some of those pressures come from this building, I believe.

But the point is that it it extremely difficult for an administrator with very limited funds not to respond, to say, yes, we're going to emphasize and spend lots of money on icing this year, and obviously, something else drops by the wayside.

Thank you.

Mrs. MORELLA. You know, I'd like to pick up also on following up on the question that Mr. Brown had asked that you'd respond to. And maybe, Mr. Poritzky, this is pretty much addressed to you.

You suggested that inadequate coordination between the operational sections and the technology developers is really a long-standing problem at FAA.

I wondered if you might be more specific in describing the internal relationships between the various technical and operational components of the agency.

And if anyone else wants to comment on it——

Mr. PORITZKY. It's a delicate one, of course.

Mrs. MORELLA. Right.

Mr. PORITZKY. The Air Traffic Service is at the front of the FAA with respect to the users. The Air Traffic Service, with its large operation, can make or break an airline operation, for example.

For obvious reasons. They are, in effect, in control of the operators', not just the airlines', the operators' destinies, on a particular day or on a particular week.

They are also at the forefront of assuring safety.

The other services in FAA, the innovators, certainly the policy people are not the size gorillas that the Air Traffic Service is.

The Air Traffic Service—and I tried to say it earlier—has been resistant, and I think we've all said this, has been somewhat resistant to innovation at probably more the middle management level than either the people in the field that Mr. Stevens talked about or at the very top.

This is—and I sound like a broken record—this is why there needs to be a leavening mechanism, something that evens the playing field, that says, even though it may cause some problems for the controllers, we will make this innovative change because it benefits the entire system.

So that the relationships inside, which, incidentally, have not been helped, in my view, by the most recent initiative to establish several of the FAA elements as businesses, business of airports,

business of the Air Traffic Service, business of Research and Acquisition.

I don't think that's helpful because it tends to split these organizations apart, rather than assuring that they work together as a single entity.

I think that's all I want to say.

Mrs. MORELLA. I want to Mr. Stevens about what type of, the modernization process that Loral is involved in.

Could you tell us a little bit about the type, a little bit about whether you're on track. I know you said you were, maybe something about cost.

Give us a little update on it.

Mr. STEVENS. Surely. If I read your question to be more directed at the restructuring of the Advanced Automation System program——

Mrs. MORELLA. Yes.

Mr. STEVENS. [continuing] the major element of that is the Display System Replacement program.

We have completed a very rigorous set of requirements redetermination, flowed those requirements down through a detailed set of specifications, and those specifications through the natural evolution of the process have been driven down to very low levels of the operational requirements of the system.

Those specifications were translated into engineering design documents. The engineering design documents have led to the development of the software package.

In fact, the majority of the software was delivered on schedule at the beginning of November of this year. The hardware development is on schedule.

We've turned the software into the integration and test program. It's proceeding well in that test program thus far.

As of the close of the accounting month in November, we were $9 million favorable to our projected costs for the work accomplished to date.

As we look forward through the test program and as we transition that program to the FAA's test facility in Atlantic City, we're on schedule and don't see any insurmountable obstacles to the accomplishment of milestones in the future.

We are in fact now working with the FAA in areas to explore how much we might be able to improve that schedule. It's a little premature for me to comment this morning that we've achieved a lot of success in moving the schedule forward, but we're exploring avenues to do that.

Mrs. MORELLA. Thank you. I look forward to visiting with you, too, soon to see some of the progress.

Mr. STEVENS. It will be our pleasure.

Mrs. MORELLA. Great. Thank you. We've been joined by Mr. McHale, the gentleman from Pennsylvania, who is most interested in this issue.

Mr. McHale, would you like to ask any questions of our experts in the field?

Mr. MCHALE. Thank you, Madam Chairwoman. As you indicated, I just arrived a moment ago and I apologize that I was not here for the principal part of the witnesses' testimony.

If I move into an area with one brief question that you have covered or perhaps is beyond the scope of the panel, I apologize.

I have a strong interest in tilt rotor aircraft. I also serve on the National Security Committee, where the V-22 is a subject of some considerable inquiry. The Marine Corps is moving forward with rapid acquisition of the V-22. It's their top aviation priority.

My question to you has to do with the parallel impact of tilt rotor aircraft on the civilian transport industry, touching on issues such as air traffic control and really kind of a broad vision of the future in terms of the potential impact that tilt rotor aircraft would have upon the civilian transportation industry.

I would throw that out to perhaps Mr. Stevens or anyone else who would want to comment.

If, in fact, as a result of DoD acquisition policies, we simultaneously move into the widespread use of tilt rotor aircraft, airplanes that land like helicopters, what impact will that have on such issues as air traffic control, R&D within the FAA?

Are you incorporating a vision of tilt rotor aircraft into your view of the future?

Mr. STEVENS. I don't know that this will directly address the essence of the issue, but insofar as the systems that we're currently involved in with their design and development, those systems are structured around a requirements set that should include all manners of air traffic in their designated air space.

So insofar as tilt rotor aircraft might increase a volume in a specific region of air space, the systems have been sized today to handle a substantial amount of increased volume and I don't see that that would necessitate an impact from that rather narrow point of view.

Mr. MCHALE. Lehigh Valley International Airport is located in the heart of my district. Those who are currently on the airport authority are looking at such things as land-banking so that additional runways can be built 20 and 30 years from now in order to preclude residential and commercial development on land that they believe may be needed for future runways.

I guess my final question is, is that sensible, or do we anticipate that tilt rotor aircraft may dramatically change our land use policies and our air traffic control policies, in light of the fact that many passengers at a lot of airports in the future won't be taking off from traditional runways. They will be taking off from what we would today describe as helipads.

Is the technology of the tilt rotor aircraft a likely major change in the future of FAA R&D and air traffic control?

Dr. FEARNSIDES. Let me take a stab at that, Mr. McHale.

First of all, with respect to your first question on tilt rotor aircraft, the Center for Advanced Aviation Systems Development, which I head, did a study on that a couple of years ago, which I feel very fuzzy about, but would be happy to submit for the record to give you some thoughts.

I would hesitate to summarize them because I haven't thought about it in a while.

The question is, and you're tying it into long-range planning, airport development, is of course right on target.

One of the major issues is the question of the economics, both of the aircraft itself and of having airports or vertical V-22 kinds of aircraft, airports inside close to the city. And the issue is what kind of an advantage is that? How expensive is the real estate?

I agree with what Mr. Stevens said, that there probably are no fundamental ATC issues associated with that. But there are some important economic issues.

I think that land-banking is probably a good idea. And I think that as we think about the FAA's budget and particularly, the airport improvement program, I think it's probably time for thinking about some new ideas as far as funding airport development.

I know the Airport Councils International has come up with some ideas on airport banking, kind of a Fannie Mae for airports. And I think that these ideas really deserve further consideration. It's something we need to keep looking at.

But I don't think that aircraft like the V-22 are going to have a huge impact on the system in a short time. It will have to evolve.

These decisions—you can imagine, land-banking—did you say you were at Lehigh County?

Mr. MCHALE. Yes.

Dr. FEARNSIDES. I come from Philadelphia.

Mr. MCHALE. That's a suburb of Lehigh County.

Dr. FEARNSIDES. A suburb of Lehigh County, right.

[Laughter.]

I think that the issues of planning an airport in Lehigh County are probably a lot easier than they are in downtown Philadelphia.

Mr. MCHALE. And that's really what I'm suggesting, particularly with the decision by the Marine Corps to go forward rapidly with the acquisition of the V-22.

Dr. FEARNSIDES. Right.

Mr. MCHALE. An enormously expensive aircraft will inevitably become more reasonably expensive in terms of civilian usage, the reliability. The kinks are going to be worked out and the dollars, I think, will stabilize.

Dr. FEARNSIDES. Certainly.

Mr. MCHALE. And therefore, I believe that in the future, our airports will look dramatically different and, inevitably, there will be a domino effect from that in terms of R&D. At least I would hope so.

And so I'm simply suggesting that, to the extent that the Marine Corps and other services move toward the acquisition of a reliable tilt rotor aircraft, we should anticipate in our planning and in our R&D there will be a civilian impact and accommodate that expected impact.

Dr. FEARNSIDES. I think that's right. And I think the pacing item may be the infrastructure needed to accommodate it.

Mr. MCHALE. Yes.

Dr. FEARNSIDES. The aircraft itself is probably not going to be the pacing item.

Mr. MCHALE. Madam Chairwoman, thank you very much.

Mrs. MORELLA. Thank you very much, Mr. McHale.

I just have two brief questions. One, I wanted to pick up again on Mr. Poritzky's comments with regard to asking him how he would characterize the management and technical expertise of FAA

team leaders, program managers, and other senior officials, how that would relate to their industry counterparts?

And if any of the others would like to comment on that, I'm curious about the personnel situation.

Mr. PORITZKY. That's a very difficult question, of course, as you know.

I think that—let me say it this way. The decline in FAA personnel began almost 20 years ago. It was in the tenure of Administrator Langhorn Bond, who, toward the end of the Carter administration, chose, under pressures of all kinds, to reduce the Washington complement of FAA.

Since that time, there has not been a significant infusion of new people. There have been some, and there have been some very good people moving into FAA. But the numbers have been very, very small.

What has happened in a number of instances that I think I'm aware of, is that the good people invariably have floated to the top. They are now in the leadership positions. But the numbers of people below them is pitifully small. The competence is limited.

There has not been—at the same time, interestingly enough, the middle management education—the FAA had a program in which some, I think two dozen middle managers were sent to universities, to three or four universities for a mid-career master's program.

That also died at about the same time. I personally think that that's a very, very bad thing. There has not been, and I said it in the statement, in recent years, adequate attention on education or higher education of FAA's people.

I think that inevitably has an effect.

It's the point I tried to make in the statement, that I believe there is a desperate need for an infusion of technologists, other experts—I'm not trying to isolate technologists alone, of course, but I think there is a desperate need for it.

There is another point that I think I would want to make without characterizing individuals because that doesn't seem appropriate to me.

The military does this and the French have succeeded eminently in this. That is, that the qualified experts are moved within the organization from, in the case of the French civil service and the military, I believe, U.S. military, from operations to engineering to policy to flight standards, so that as the executives rise, two things happen.

One, they have a better appreciation of the totality of FAA's job, rather than a single element of it.

But just as important, they have an understanding that they really need to work together, that the idea of a separate business, as it's now being talked about, for Air Traffic Service and a separate business for Research and Acquisition, doesn't make any sense.

Airports are in exactly the same situation. The airport element is an element of aviation that needs to be closely integrated.

So that I think the need for more technical capability inside and the need to break, as I've tried to say in the statement, to break down the walls, I think are the crucial elements here.

Thank you.

Mrs. MORELLA. Education, expertise, streamlining—I don't know how the reinvent government, number one and two, has affected this. It appears to me that one of the intentions was to have fewer managers for the number of people, to go from one to 15 rather than one to eight.

I guess my final question to all of you, which may incorporate responses to that question is, what do you think that Congress can and should do to address the kinds of problems that we have been discussing here to help FAA solve the long-standing cultural problems and institutional problems that we've addressed—operate team, management, technology coming into the forefront?

Dr. FEARNSIDES. Madam Chairwoman, I think you phrased the question exactly correctly. But first, I think you finally did it. Mr. Poritzky and I couldn't go a whole morning without disagreeing.

I think that, first of all, I do agree that there are a lot of excellent people in the FAA. And I think there are a lot of well-motivated people in the FAA.

I think there are two or three important things that keep people of the kinds of skills and capabilities that Mr. Poritzky would like to see from coming to the government.

One is that the pay and benefits are not equal to what industry can hire. And so, this concept of giving the FAA some measure of personnel reform, when put together with other reforms, I think is an excellent idea.

The second thing is that there is a tremendous amount of process versus product associated with working in the Federal Government, largely due to federal acquisition regulations, due to federal personnel regulations, and the like.

And for an operational organization like FAA, FAA really is a different kind of federal organization. It really is more like a telephone company or an airline in the way it operates, with the exception of its regulatory functions, of course, than it is like a regular federal agency.

And I think that the oversight process—the requirement to operate as a federal agency is very, very difficult and somewhat dispiriting for the people who have to labor under tremendous process burdens.

For example, one of the things I tease my friends at GAO about is their insistence on process. So if a program manager happens to be over budget and over schedule, past his schedule, and GAO criticizes him for it, they're likely to criticize process rather than product.

And all of that process makes it very difficult to get the job done.

This is why, as I said in my opening statement, I think that really some truly fundamental reform is necessary. And as you move forward with your legislation, you know that both of the authorizing committees are considering more fundamental FAA reform legislation.

And I think that the Congress really needs to take the opportunity and move out on that this year.

Mrs. MORELLA. Thank you, Mr. Fearnsides.

Mr. Stevens?

Mr. STEVENS. Madam Chairwoman, let me offer you an observation, from perhaps a narrow basis, but to in fact effect the restruc-

turing of the Advanced Automation System. We had the occasion to work very intimately with the FAA's integrated product team for the enroute segment over an extended period of time.

And by that, I mean at least nine, ten, eleven months. Much of that was locked up in 14-hour days, working weekends. Certainly, from our view, there was no shortage of enthusiasm or dedication from the folks that we were working with.

And as you might expect, some of those discussions were animated and wherein, we were not always in perfect agreement. But everybody came back to the room the next day and put in a lot of hard labor.

So I think that, at the essence, those essential elements that make teams work are evident in the FAA insofar as we're able to determine.

I guess we share a concern that others share that all the integrated product teams will work as effectively as the one has for the enroute segment.

With respect to legislative reforms, we are participating in and looking forward to the reformation of the procurement regulations in the FAA, and we think there are very good things to be gotten from that.

Thank you.

Mrs. MORELLA. Thank you, Mr. Stevens.

Mr. Fleming?

Mr. FLEMING. Thank you. At the fundamental level, I agree completely that personnel and procurement reform are required, as is the development of a funding stream for FAA's programs which will enable program managers to plan beyond next month, as they try and juggle funds not yet obligated, the current-year budget or appropriation, next year's appropriation and planning for the one after that.

Absent fundamental changes, I am not sanguine about the future prospects for the FAA, any part of it.

I think the reorganization of government changes have hurt badly because, in some cases, very capable people were offered buyouts, and they took them.

The reduction in the level of supervisors to employees has been painful. I think it clearly was needed, but, to be honest with you, I think what's needed yet at FAA is just take whole layers of management because they've probably got at least four more than they need.

They need to simplify their regional organization, which would dramatically reduce the overhead they have to carry.

All of this is going to be very painful if it comes to pass to a lot of people. But that's what's happened in industry. It has happened to my employer.

In November, 1992, we reduced the size of ATA by one-third and did it in one hour, and nobody sued us. And we're now more efficient than we were because that's what it was all about.

I would hope the change at FAA need not be so painful. But it's very clear that there have to be some fundamental changes.

In my discussions with some senior FAA managers, I find more people interested in getting out of FAA and out of the civil service, and nobody is coming in.

I am married to a civil servant, 34 years' service with the Department of Defense. She works for a relatively small element that has not hired one new employee in the last seven years.

This is the sign of a dying organization.

She tried to retire on December 1st, but nobody was there to retire her because all the administrative people were laid off. She's going to leave the federal service on January 3rd, and I fear that more of that sort of thing will adversely affect FAA.

Mrs. MORELLA. Mr. Poritzky?

Mr. PORITZKY. Just a final point. I agree wholly with what Jack said. I don't know where we disagree on this and I certainly agree.

Dr. FEARNSIDES. I agree, too.

Mr. PORITZKY. Thank you. All right. Thank you. I think that I agree certainly with what Roger is saying as well.

But I do believe that, and I tried to say this in my statement, that the weapons that have been given in this year's appropriation to the administrator to propose and to create a new personnel system, a new procurement reform system, with the action earlier of a longer tenure for the administrator, which may or may not be helpful, gives him weapons to deal with.

If he's enabled to use them and he is willing to use them, I think there is hope. I certainly hope there's more hope than Roger is implying.

Mrs. MORELLA. I thank you all very much. I wanted to pick up on what Mr. Fleming said.

I am an advocate of civil service and our civil servants. And I say servants because they do serve the public. We tend to forget that. I forget it less than others because I have such a large number of federal employees and the private sector reliance on federal institutions and employment.

But I am concerned with the way the down-sizing has been done, with shutdowns of government, the fact that people throw numbers around about the number of federal employees that will no longer be part of Federal Government.

It has been a deterrent to young people. You no longer find young people in high school saying, I want to work for the Federal Government, whether it's FAA or whether it's even NIH or any of the others, and a chilling effect for those who have been there for a number of years who are looking forward to leaving.

And I think this ties in to what all of you have said, Mr. Poritzky, too, when you talk about a management team and design team.

We also have to make sure that we continue to attract the best and the brightest, as we did, and I know that we can.

So I do share that.

I know that other members of the Subcommittee have asked me if they could submit some questions to you. I would like to ask if that's all right with you.

I thank you all very, very much for being here today. I look forward to having you come back again—Mr. Fearnsides, Mr. Stevens, Mr. Fleming, Mr. Poritzky.

And now I'm going to ask that second panel that have been very patient if they would come before us.

Panel Two has: Dr. Robert E. Whitehead, the Associate Administrator of the Office of Aeronautics of NASA; Dr. Alan Thomas, Deputy Assistant Administrator, Oceanic and Atmospheric Research at NOAA; and Mr. William "Bud" Laynor, who is with the National Transportation Safety Board.

I think two of you have already submitted testimony which we have intact and will be part of the record.

I think I'd like to give you, rather than just jumping at a question, perhaps give you an opportunity again in like a couple of minutes, to make any comments that you would like to pertaining to the hearing, particularly because you've been so patient. You've listened to the other panelists give their opinions in terms of the operation.

So perhaps, unless you have a particular line of progression and order, maybe I'd start off with Dr. Whitehead. You may need to go a little closer to the mike. Right.

STATEMENT OF DR. ROBERT E. WHITEHEAD, ASSOCIATE ADMINISTRATOR, OFFICE OF AERONAUTICS, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, DC

Dr. WHITEHEAD. Thank you. I apologize that I have a slight cold, so I'm going to have to try harder to be heard.

NASA and the Aeronautics Enterprise appreciates the opportunity to come and make some comments and have a discussion about FAA and our relationship in R&D.

I'll just make a few comments.

First, I'd like to refer to the fact that, for the first time since the mid-'80s, the National Aeronautics R&D community has a national policy through the National Science and Technology Council, has a roadmap for us.

I'll only just mention the three top goals of that national policy.

It's to maintain the superiority of U.S. aircraft and engines.

Improve the safety, efficiency, and cost effectiveness of the global air transportation system.

And ensure the long-term environmental compatibility of the aviation system.

I mention those only because two of the three areas specifically, and the third less directly, are areas that NASA and FAA cooperate very closely in. And that's development of technology for air traffic management and in safety and environment.

I'd like to make sure that it's on the record, and we think it's important, that while we work very closely with the FAA in a number of ways, we're fundamentally different as organizations. And I think that's important to note.

FAA is a large operational and regulatory organization who does a substantial amount of systems development and some research.

NASA, in general, and in the aeronautics enterprise specifically, is a research and technology organization. It's our core business. It's what we think about and what we work on and what we do all day, every day.

And so, that creates a culture for us that at the top level, is different than the FAA. It creates a dual relationship with that agency.

One is that we are research partners in the areas that we cooperate on research and there are significant ones. And the second, the FAA is clearly a customer for the technology and the research that NASA does in a number of areas.

So we do things together as research partners, but we try to and have to pay a lot of attention to what the requirements of the FAA are as operators of an air traffic system, as stewards of aviation safety for the nation, and as representatives in the international community of environmental compatibility for aviation.

One more point I'd like to make, and that is that a lot of discussion here in the previous panel had to do with air traffic control and the air traffic management system, and that's a very important part of the FAA and what we cooperate with.

However, we also have large cooperative programs in environmental compatibility, noise reduction, engine emissions reductions, in aviation safety, in severe weather detection and avoidance. And those investments in the present day, actually, the cooperative programs are larger than our cooperative efforts in air traffic.

So we shouldn't forget, with our legitimate concerns about the air traffic system, that environment, safety, weather are all areas that are critically important for cooperation and for new technologies.

Thank you.

Mrs. MORELLA. Obviously, so. I don't think any of us are allowed to forget for very long the importance of that, including the airport, aircraft noise reduction. Certainly safety.

[The prepared statement of Dr. Whitehead follows:]

Statement of
Dr. Robert E. Whitehead
Associate Administrator for Aeronautics
National Aeronautics and Space Administration

before the

Subcommittee on Technology
Committee on Science
House of Representatives

Good morning, Madam Chairwoman and Members of the Subcommittee. I am pleased to have the opportunity to discuss NASA's relationship with the Federal Aviation Administration (FAA) in the context of a national partnership in aeronautics research and technology, and outline our perspective on national research and development (R&D) directions and strategies required to meet the challenges ahead.

NASA performs aeronautics research in areas where FAA does not, such as technology development for aircraft performance enhancements; likewise, FAA conducts research in areas where NASA does not, such as airport security technology and fire safety. However, there are many areas in which we have strong coordination and cooperative programs. Both NASA and the FAA have the skills and facilities to conduct aeronautical research and technology development. In this era of tight budgets, it is especially important for both our agencies to cooperate in order to be successful in fulfilling the needs of the Nation's aviation community.

Goals for a National Partnership

The growth in the aeronautics industry, since the infancy of powered flight, has been the result of intense cooperation among government, industry and university partners. Government investments in aeronautics have been focused on science, technology, infrastructure and military aviation. These investments provided the impetus for the historic industry successes in aeronautics.

Today, the aeronautics industry is facing a number of difficult, new challenges. First, the end of the Cold War has permitted a reduction in defense expenditure, including significant cutbacks in the development of new aircraft and engines. Second, the weak financial state of the global airline industry has seriously affected orders, backlogs and deliveries of new civil aircraft. Third, foreign governments have strongly supported the development of their own aeronautics industries through major investments in infrastructure, technology, and development programs, challenging U.S. competitiveness in this industry.

Although the combination of these factors has had a significant impact on the aeronautics industry, the United States is still the leader in aeronautics

technology and manufacturing. We must maintain leadership in this global industry if we are to retain the economic and national security benefits that derive from aeronautics. Nationally, we have the infrastructure—government, industry and universities—to maintain leadership. We must now renew our focus on partnerships to meet national challenges and accomplish national goals.

In September 1995, the National Science and Technology Council (NSTC) published "Goals for a National Partnership in Aeronautics Research & Technology." It envisions, "...world leadership in aircraft, engines, avionics, and air transportation system equipment for a sustainable global aviation system." To achieve this vision there are three national goals:

1. **Maintain the superiority of U.S. aircraft and engines**;
2. **Improve the safety, efficiency, and cost effectiveness of the global air transportation system**; and
3. **Ensure the long-term environmental compatibility of the aviation system**.

In order to accomplish these goals, NASA will work more closely with our partners, including FAA and DOD, industry and universities. NASA's role will continue to be the development of high-payoff component technologies, validation and integration of high-risk technologies, as well as exploration of advanced new concepts to achieve more revolutionary gains. We will conduct this role in close cooperation with our partners for the Nation's benefit.

Framework for FAA-NASA Cooperation

NASA traditionally has conducted research to optimize the performance of aircraft by addressing technology challenges in aerodynamics, materials and structures, propulsion, and controls and guidance disciplines. While many great strides have been made with this approach, today it is clear we need to look at the aircraft not just as a single entity consisting of many subsystems, but as one part of an integrated aviation system. The aircraft—whether a subsonic or high-speed transport, civil tiltrotor or general aviation aircraft—must operate in an airspace system under the constraints of environmental and safety regulations. Our national partnership looks at the whole system, and each participant uses its resources to address areas to which it is most suited. NASA considers FAA not only a partner in this endeavor, but also a customer for advanced technologies.

NASA Aeronautics has had a long-standing relationship with the FAA, dating back to the late '60s and early '70s, when NASA-FAA teams jointly developed the safety criteria that would be required for the new "jumbo jets" being manufactured by the Lockheed, Boeing and Douglas. During this period, FAA established its first engineering field office at the NASA Ames Research Center to provide the FAA with access to the leading edge in aeronautics knowledge to support its safety mission. The success of the Ames field office inspired the establishment of a similar office at the NASA Langley Research Center.

These collaborative relationships set the stage for establishment of the "FAA-NASA Coordinating Committee" in 1980, to provide formal executive level interagency coordination. In 1990, the FAA and NASA Administrators renewed

the 1980 agreement to continue executive level exchange of information between agencies and established six executive-level Memoranda of Understanding (MOU). In September 1995, the NASA and FAA established a seventh executive level MOU. The seven MOUs are: Airworthiness Research, Cockpit-Air Traffic Control (ATC) Integration Research, Airspace System User Operational Flexibility and Productivity, Severe Weather Research, Human Factors Research, Environmental Compatibility Research, and Program Support. There is one Joint Sponsored Research Agreement (JSRA) with the FAA for Advanced General Aviation Transport Experiment (AGATE).

The NASA-FAA partnership operates under a framework based on the national policy goals established in the NSTC document. Strategic plans, responding to national policy, are folded into the seven MOU and various Joint Sponsored Research Agreements (JSRA). Specific research is implemented under Memoranda of Agreement (MOA) and Work Packages (WP) that fall under a particular MOU or JSRA.

NSTC Goal 1—Superior U.S. Aircraft

The major barriers to superior U.S. aircraft are foreign competition and product affordability. NASA's role is to provide long-term investments in basic and applied research that will enable innovation in commercial aeronautics. Another NASA role is the provision of national aeronautical test facilities. These are large-scale, generic facilities that support government and industry needs. Together, FAA and NASA are working to ensure today's U.S. aircraft remain safe and to provide a basis for certification of future aircraft.

The objective of our Airworthiness Research MOU is to pursue technologies that will improve the airworthiness and flight safety of aircraft operating within the National Airspace System (NAS). Within this MOU, there are several MOAs that the FAA and NASA are implementing. I will highlight two of these: Aging Aircraft and Certification Basis for High Speed Civil Transport (HSCT) Aircraft.

Airline operators are increasingly using their aircraft longer than their original design economic life. To keep them safe, the airlines need affordable ways to inspect and maintain these aircraft. The NASA/FAA Aging Aircraft program encompasses the technologies needed to address the aging aircraft problem, including: fatigue and fracture, structural analysis methods, corrosion, flight loads analyses, non-destructive inspection and non-destructive evaluation, human factors, and maintenance and repair. In FY95, NASA developed methods to reliably and economically detect small fatigue cracks extending from rivets, and long cracks hidden by the outer skin of a splice joint. In FY96, we plan to verify methods to predict the residual strength of airframe structure.

The objective of the agreement on Certification Basis for HSCT Aircraft is to ensure that a future HSCT will be able to be certified. NASA and FAA are working together to develop the pre-certification process, guide the NASA High Speed Research (HSR) program to incorporate certification issues, and support a program to establish internationally harmonized certification criteria. In FY96 NASA will identify and integrate key certification issues into the HSR program.

NSTC Goal 2—Safe, Efficient & Cost Effective Global Air Transportation

The major issues in global air transportation today are airspace system capacity, user flexibility, predictable access to airspace, and aviation safety. The explosive growth in air travel following the Airline Deregulation Act of 1978 placed heavy demands on the National Aviation System (NAS). Airspace users cite insufficient capacity, limited access, and operating restrictions as contributors to excessive operating costs and decreased efficiency. The current air traffic management infrastructure is severely outdated and will restrict the introduction of new technology. As FAA upgrades that infrastructure, opportunities exist to introduce new technology to enhance safety and efficiency in flight operations. NASA expertise in aeronautics, combined with FAA expertise in air traffic management, will result in an integrated air-ground system that more fully meets the needs of airspace users in airspace system operations and aviation safety.

The MOUs for Cockpit-ATC Integration Research and Airspace System User Operational Flexibility and Productivity, and the JSRA for AGATE support this national goal. These agreements address joint efforts in today's air traffic system, as well as aggressive research efforts to support the development of the air traffic system of the 21st century.

<u>*Cockpit - ATC Integration Research*</u>

Under this MOU, NASA and FAA pursue ATC-related technologies and techniques that will increase NAS capacity. We also are working to improve the safety and efficiency of flight operations through ATC system automation and cockpit technology. There are several MOAs under this MOU, including ATC software, wake vortex investigations, precision terminal guidance, navigation and control technology, the joint acquisition and operation of facilities, and collaboration on modeling and analyses of the airspace system and aircraft technologies.

NASA is developing prototype tools to assist air traffic controllers with decision-making in the high-density terminal areas. Under the Center-TRACON Automation System (CTAS) agreement, NASA developed and evaluated CTAS in a laboratory environment. The FAA is currently evaluating CTAS in Denver and Dallas for implementation into the NAS. The Surface Movement Advisor (SMA) agreement provides for a FAA/NASA partnership to develop, evaluate and implement the SMA. The FAA will first evaluate SMA in Atlanta in 1996.

In Wake Vortex Systems Research, NASA provides methods and integrated systems that will detect and predict vortex hazard and determine safe aircraft separations under single and multiple runway operations. This work will permit the FAA to safely revise current separation standards to increase system capacity. In FY95, NASA validated a two-dimensional wake vortex model, defined a concept for aircraft vortex spacing system and provided preliminary separation information to FAA. In FY96 NASA will field test the Dynamic Runway Occupancy Measurement system at a major airport.

NASA and the FAA collaborate to determine the feasibility of techniques to achieve very high precision improvements to the navigational accuracies

possible with the use of the Global Positioning System (GPS) during approach and landing. Results of this effort are being applied by the FAA in its global navigation satellite system for very high precision navigation services at airports that are affected by low-visibility.

Under the Current Technology Glass Cockpit Simulator MOA, NASA and FAA acquired and now operate an advanced training simulator which provides critical research capability for the National Plan for Aviation Human Factors. Under the Air Traffic Control Automation and Human Factors Research agreement, NASA operated this simulator and FAA operated one of its air traffic simulators to improve aircraft operating procedures in the Pacific. Now, with the appropriate systems, airlines operating in the Pacific use these procedures and enjoy safer and more cost-effective operations.

Airspace System User Operational Flexibility and Productivity

This MOU, signed in September 1995, had its genesis in NASA/FAA cooperation in CTAS and Terminal Area Productivity (TAP). In March, the FAA and NASA Administrators agreed that the R&D capabilities of FAA and NASA would provide a basis for strong partnership in air transportation system development. The result is a unique relationship that ensures the fastest implementation of technology with the most responsible use of resources.

The objective of this new MOU is to integrate R&D activities to achieve an air transportation system that better facilitates user operational flexibility and productivity throughout the airspace system, decreasing delays while maintaining the highest level of safety. NASA and FAA will develop and validate system improvements which can be implemented within next ten years. The MOU covers all FAA Research, Engineering, and Development activities related to traffic-flow management, and related advanced ATM functionality, as well as all NASA activities related to ATM technology, including the Advanced Air Transportation Technology (AATT) Program and other relevant ATM initiatives. Areas for cooperative or joint activities may include, but will not be limited to: roles of flight crews and air traffic controllers; integration of ATM, cockpit and fleet management; cockpit situational awareness; conflict detection and resolution; flight restrictions; safety analysis; and cost-benefit assessments.

The activities covered by this MOU will be managed by an FAA/NASA integrated product team (IPT) led by the FAA Traffic Flow Management IPT leader. NASA will designate a deputy team leader and will participate as a full partner with FAA to ensure that both near- and long-term research perspectives are maintained. The interagency IPT will be responsible for all aspects of the initiative, including R&D requirements definition, program planning, oversight, and communications with the user community. This activity will be monitored and guided by a committee comprised of users, industry representatives, and technical and operational experts drawn from existing FAA and NASA advisory committees. In FY96, the interagency IPT will develop an integrated program plan and initiate the early tasks.

Aviation Safety and Human Factors

Under the Severe Weather Research MOU, NASA and FAA develop technologies to improve the safety of aircraft operations in severe weather conditions. Under this MOU and the Airborne Windshear Advanced Technology MOA, our agencies developed and demonstrated, in an operational environment, airborne detection and warning technology leading to reduced risks associated with severe windshear conditions. This effort achieved 100% of its technical objectives by the end of FY93. Airlines are putting this technology on aircraft today.

NASA and FAA conduct safety research to improve the efficiency of air- and ground-based flight operations and reduce the consequences of human error. The objectives of the Aviation Safety and Automation agreement concern causes of human error, human interface to automated systems, information transfer and management, and flight crew performance and aircraft-ATC integration. NASA also supports the FAA with the Aviation Safety Reporting System (ASRS) under the Program Support MOU. The ASRS provides information to the FAA and the aviation community to assist the FAA in reaching its goal of eliminating unsafe conditions and preventing avoidable accidents.

NSTC Goal 3—Environmental Compatibility

The major issues in environmental compatibility are noise and emissions. NASA's long-term investments in basic and applied research set the technical foundation for the environmental policy-making and regulatory processes and enable innovation in commercial aeronautics. NASA has the key technical role in a unified regulatory-R&D approach led by the FAA to assess environmental concerns, plan R&D, shape technical requirements, identify feasible technologies, and implement aircraft and engine certification regulations to mitigate the potential impacts. In this role, NASA develops noise reduction technology, and, jointly with FAA, noise abatement flight profiles and noise analysis-impact models. NASA also performs research to define the atmospheric impact of aircraft emissions and develops low emission engine technology.

The goal of the Environmental Compatibility Research MOU is to develop technologies that will improve the environmental compatibility of aircraft operations by addressing three objectives: Aircraft Noise Reduction, Engine Emissions, and Sonic Boom.

Under the Subsonic Aircraft Noise Reduction agreement, NASA and FAA plan to develop aeroacoustics technology to reduce installed engine noise levels by 3–4 dB relative to the state-of-the-art subsonic aircraft propulsion systems. In FY95, NASA accomplished verified adaptive and active noise control duct treatment on low-speed fan. In FY96, NASA will validate concepts for 3 dB jet noise for 1.5–6 bypass ratio engines and 3 dB fan noise reduction relative to 1992 technology and validate concepts to improve nacelle duct treatment effectiveness by 25% relative to 1992 technology. NASA will complete a flight acoustic database and a simulation database on low noise procedures for civil tiltrotors in FY96.

In the area of emissions, in FY95 NASA completed an assessment of the atmospheric effects of stratospheric aircraft, and supported the FAA delegate to the International Civil Aviation Organization's Committee on Aviation Environmental Protection. In FY96 NASA will conduct the first field campaign with a DC-8 Flying Laboratory with climate-related measurements and the first program-level assessment to support the 1997 United Nations Environmental Program/World Meteorological Organization ozone assessment report.

Summary

NASA and FAA have had a long-standing tradition of good and productive collaboration. I have outlined some of our cooperative efforts today. This cooperation is being strengthened by the new emphasis on a national partnership in aeronautics; the blueprint laid out in the NSTC's September report sets the stage for our partnership in the future and focuses attention on three national goals. We look forward to continuing our successful relationship with FAA in this new context.

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Mrs. MORELLA. Dr. Thomas?

STATEMENT OF DR. ALAN R. THOMAS, DEPUTY ASSISTANT ADMINISTRATOR, OCEANIC AND ATMOSPHERIC ADMINISTRATION, SILVER SPRING, MARYLAND

Dr. THOMAS. Yes, thank you, Madam Chairwoman.

NOAA, like the Federal Aviation Administration, is an operational agency and has a field structure that it has to work with to provide our services to the public, to private sector, as well as other federal agencies.

And in addition, we also are going through a major modernization program that is undergoing now and has reached somewhat the midpoint, or maybe a little beyond. And we are trying to implement complex systems which will influence the life of our field structure.

So we do have problems of how do we make these systems user-friendly and integrated so that the field, weather forecaster in this case, can continue to do not only his job, but a much better job in the field.

NOAA, both through our operational national weather service, as well as our environmental research laboratories, have had a long history of working cooperatively and very productively with FAA.

An example would be the NEXRAD. Back as long ago as the '70s, FAA, the Department of Defense, which is another operational agency, and NOAA, have pooled their R&D resources to try to better understand weather radar, and now we're seeing the products in the implementation of both the NEXRAD program, but also the terminal doppler radar program.

One of the issues that has been brought out is the fact that we need to focus our R&D on the operations. We have tried to do that and we can see major influences on the nature of the weather service's modernization.

Also, because weather is so ubiquitous and so important to the missions of multiple agencies, we do have an active involvement with FAA, but also with the Department of Defense, other agencies like EPA and the Department of Energy.

So our R&D program has many, many linkages into the federal system, as well as many of the private entities, such as universities and private corporations.

One element I think of the R&D program that we've been struggling with, and some of these issues were brought out today, has been how do we make the transition? I think the word used earlier was insertion. That is, how do we make the transition from R&D to the operations?

We've paid a lot of attention. We can't say we have answers, but we have worked very hard, for example, to involve the users through prototyping, through demonstrations, through working the system back and forth many times with our weather service colleagues.

Also, risk reduction. That is, how do you define the system so that when you go into the procurement cycle, you have kind of isolated the technical unknowns.

So those are sort of some of the common elements that we share with FAA. We have been involved, and at some point we will sup-

ply testimony that goes into the specifics of the program involvements that we have.

But, clearly, we are involved, as I said, in things like the doppler program, but very actively, both in the aviation safety, as well as air traffic management, based on the tools that we have developed within the NOAA for its weather service operations.

With that, I'll end and thank you for the invitation.

[The prepared statement of Dr. Thomas follows:]

STATEMENT FOR THE RECORD
OF
ALAN R. THOMAS
DEPUTY ASSISTANT ADMINISTRATOR
OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVE
DECEMBER 7, 1995

NOAA Research Impacting the Federal Aviation Administration's Long Term Weather Research and Development Programs

Thank you, Madam Chairwoman for inviting the National Oceanic and Atmospheric Administration (NOAA) to make a statement at this hearing. NOAA, like the Federal Aviation Administration (FAA), is an operational agency that provides products and services to the American public, the private sector and other Federal agencies. NOAA, also like FAA, is involved in a major modernization of its national weather system operations. Since weather is so ubiquitous and critical to the operations of many Federal agencies, NOAA is involved in both operational weather support and cooperative research and development (R&D) activities with many Federal agencies, including FAA, DOD, NASA, DOE, EPA, and many others. Weather data, operational products and R&D results that NOAA produces for its own use are directly relevant to other agencies; in addition, NOAA's R&D capabilities are also applicable to improving the operations, products and services of these other Federal agencies.

NOAA, through the National Weather Service (NWS), the National Ocean Service (NOS), and the Office of Oceanic and Atmospheric Research (OAR) Environmental Research Laboratories, has a long history of working cooperatively and productively with the FAA. An example of the past cooperation geared to long range research was the cooperative projects centered at NOAA's National Severe Storms Laboratory in the 1970s to exploit Doppler weather radar for purposes of weather warning, aviation safety and meteorological science. This long term research has resulted in the magnificent achievements represented by the operational implementation of the agency's NEXRAD program and of the FAA's Terminal Doppler Weather Radar system.

In developing its current R&D program to meet the agency's long term R&D needs, NOAA has tried to develop ways to improve its "transitioning" of R&D into operations through a number of different means For example, we have tried to accomplish more "functional prototyping" and demonstration of systems which involves closer interactions and cooperative activities between the National Weather Service and the R&D entities before specifying the requirements for new operational systems. It is critical to allow for the continual feedback between R&D program and operational services so that the needs of the operations and the new capabilities derived from the R&D program are tested, defined, and refined before large investments are made.

The following narrative summarizes current cooperative research activities between the NOAA

Office of Oceanic and Atmospheric Research, the NOAA Office of National Ocean Service, and the NOAA National Weather Service with the FAA that address many of the key scientific and technical atmospheric issues that influence aviation.

I. The NOAA Office of Oceanic and Atmospheric Research

Research in support of the FAA mission is carried out in four of the eleven Environmental Research Laboratories of the Office of Oceanic and Atmospheric Research. These laboratories have produced many products currently deployed and serving as the foundation for weather forecasting and air flight safety and management in the United States New research and development is producing additional systems that will further enhance the understanding and the predictability of weather phenomenon affecting flight safety throughout the nation.

1. Forecast Systems Laboratory (FSL)

FSL collaborates with the FAA and the NWS in the Aviation Weather Research Program (AWRP) to increase the capacity of the nation's airspace while maintaining a high level of safety The end product of this program will include increased accuracy, timeliness, and spatial resolution of the weather products used by air traffic controllers, air traffic managers, and the general aviation community. Opportunities to develop better weather products now exist because of new observing systems, recent advances in understanding the atmosphere, higher performance computing capabilities, and better dissemination of meteorological data Within NOAA, these are coming together in the modernization of the NWS.

Aviation Gridded Forecast System (AGFS)

The primary focus of the FSL's aviation weather research is the development, computation, verification, demonstration, and transition to operations of the Aviation Gridded Forecast System (AGFS), a four-dimensional gridded database consisting of meteorological analyses and forecasts of State-of-the-Atmosphere Variables (SAVs) and Aviation-Impact Variables (AIVS).

FSL has developed two data assimilation systems, one of which is the Mesoscale Analysis and Prediction System (MAPS). MAPS, also known as the Rapid Update Cycle (RUC), currently runs operationally at NOAA's National Centers for Environmental Prediction (NCEP) The RUC/MAPS system produces new analyses of atmospheric conditions every three hours on a 60km three-dimensional grid covering the lower 48 states, with buffer zones on all four sides. In addition to an analysis, the RUC generates a new 12-hour forecast every three hours. The RUC/MAPS system has tremendous value for flight planning, aviation safety, fuel savings, and air traffic management.

The second data assimilation system is called the Local Analysis and Prediction System (LAPS) which is designed to run in local weather offices and to exploit local data sources, especially Doppler radars, which are generally not available to a national center. LAPS runs on a 10-km horizontal grid and covers a movable area roughly 600 km on a side. LAPS generates high-resolution predictions hourly. Due to the system's high degree of temporal and spatial resolution and exploitation of virtually all meteorological data sources, LAPS has tremendous value for aviation terminal forecasting.

Both of these data assimilation systems rely heavily on fully automated aircraft reports of in-flight winds and temperatures provided by Aeronautical Radio, Inc. (ARINC) through the ARINC Communications Addressing and Reporting System (ACARS). About 18,000 such reports are now available every 24 hours over the contiguous United States, and up to 20% of these are obtained while aircraft are on ascent or descent. Four airlines are currently providing this information (United, Delta, Northwest, and United Parcel Service), and more airlines are being invited to contribute to this collection. A new cooperative NOAA FAA project to be discussed later will develop a water vapor sensor that can be added to aircraft thereby providing an additional critical parameter. Another very important data source feeding the RUC/MAPS and LAPS comes from the NOAA Profiler Network, a collection of about 30 vertically pointing Doppler radars in the central United States, each generating detailed vertical profiles of wind once an hour up to 40,000 feet and higher.

The output from these data assimilation and short-range prediction systems are the basis for a sophisticated information system being designed by the Aviation Weather Research Program to serve the aviation community. Since most models do not explicitly predict several parameters vital to aviation operations (ceiling, visibility, precipitation type at the ground, in-cloud icing, and turbulence), they must be inferred from the model output. A major goal of the aviation program is to produce these secondary parameters, often called Aviation Impact Variables (AIVs).

FSL will be using its Real-Time Verification System (RTVS) to undertake long-term, statistical verification of SAV and AIV grids. This system includes real-time data ingest, quality control, and grid-to-observation interpolation and will provide greater accuracy and more versatility for statistical verification analysis, which has high utility to the aviation industry.

Advanced Traffic Management System (ATMS)

Currently, weather accounts for 73% of the air traffic delays which affect the flow of enroute traffic as well as terminal area arrivals and departures. At the same time, the air transport industry is growing and is expected to continue expanding through the end of the century. To learn how advanced meteorological information from the modernized National Weather Service can help FAA reduce air traffic delays, FSL works with the Volpe National Transportation Systems Center. The emphasis of FSL's ATMS Project is twofold:

1. Apply the Aviation Gridded Forecast System to strategic planning of the airspace system;

2. To understand how advanced weather data displays can be useful for air traffic management.

Integrating advanced meteorological data sets into air traffic flight models represent a major advance in automating air traffic flow functions. These models are used to generate air traffic alerts to warn traffic managers of potential traffic congestion problems before they actually occur. FAA traffic managers use this application in their operational facilities, taking proactive measures to mitigate traffic flow problems before there is significant impact to the airspace system. Graphical displays of radar, lightning strikes, and other types of information used as an overlay upon the Aircraft Situation Display allow air traffic managers to view real-time, high-resolution prototype weather information integrated with flight data for strategic planning.

To provide for transitioning of R&D to operations, FSL is developing graphics tools designed to allow NCEP's Aviation Weather Center (AWC) forecasters to tailor NWS aviation products from AGFS grids. The forecasters use the editor to interact with high-resolution SAVs, AIVs, and observations. They also have the capability to edit (add value) to AIVs for icing potential, and to change the threshold values of the icing algorithm. Methods for editing allow the incorporation of up-to-the-minute pilot reports of icing observations and satellite data on cloud patterns. A prototype AIV editor was installed at the AWC in FY95. An evaluation of the prototype is planned for January 1996.

AGFS grids and products continue to be displayed on a real-time FSL-developed workstation at the FAA's Denver center located in Longmont Colorado. FAA forecasters use these products in their role as partners in air traffic control and traffic management decision making. To assist FSL developers in understanding the needs of aviation forecasters, FSL meteorologists have been trained and certified in CWSU operations.

FSL has developed an Aviation Weather Network which provides the FAA's Advanced Traffic Management System with high-resolution weather information for strategic planning of the national airspace system. Aviation Weather Network technology will be transferred to the Department of Transportation's Volpe National Transportation Systems Center in January 1996. FSL researchers will continue to provide upgrades to the operational Aviation Weather Network as new weather forecasting technologies evolve from the National Weather Service Modernization Program.

Water Vapor Sensing System

NOAA has implemented a procurement jointly funded with the FAA, to develop and implement a

new water vapor sensor to be installed on wide bodied aircraft This sensor will allow for a major improvement in the data available for aviation, weather forecasting, climate studies, and many other applications Water vapor is one of the most important atmospheric variables. Along with the currently available data on temperature and winds from commercial aviation through ARINC will allow for improvements in the AGFS data base in the data available for the RUC and LAPS data assimilation systems, and for weather forecasts.

2. National Severe Storms Laboratory (NSSL)

The National Severe Storms Laboratory does applied research and develops applications that both directly and indirectly help the aviation community, including development of radar algorithims and development of very short-term predictions.

Radar Algorithm Development

NOAA and the FAA have shared the cost of sponsoring NSSL to develop algorithms that read and analyze Doppler Weather Radar data and automatically detect weather phenomena that are dangerous to aircraft. These algorithms are being developed both for the Terminal Doppler Weather Radar System (now in the deployment stage) and for NEXRAD NSSL was part of the team that developed and tested the TDWR system and was the main developer of the Gust Front Detection Algorithm and the Wind Shift Prediction Algorithm that are both part of the fielded TDWR system.

NSSL has recently delivered algorithms to be installed on the NEXRAD system. These include a storm cell identification and tracking algorithm, a tornado detection algorithm, a hail detection algorithm and a mesocyclone (strong circulation) detection algorithm. In total, these algorithms have been tested and tuned to be part of the prototype Integrated Terminal Weather System (ITWS) and will be part of the fielded ITWS These algorithms have also been tested and tuned to provide warnings and short-term predictions of hazardous weather in enroute airspace.

Short-Term Predictions

In addition, NSSL is performing research that will lead to very short-term predictions (i.e. less than one hour) of the movement and evolution of storms, as well as, the prediction of the initiation and movement of severe weather on the time scale of less than 24 hours. Both of these efforts have high potential payoffs for adding capacity to the aviation system, especially during convective weather events.

3. Environmental Technology Laboratory (ETL)

The mission of the Environmental Technology Laboratory is to improve the Nation's geophysical research and services by developing, demonstrating, and transferring cost-effective remote measurement systems ETL's contributions support NOAA's largest and most important single service, namely, weather forecasts and warnings Lab activities in aviation hazards, winter icing and storms, and cloud radar are summarized highlighted below for their significance in aviation safety

Aviation Hazards

ETL has joined with NCAR and FSL to establish a 5-year program to study clear air hazards to aviation. These unseen but real dangers are caused by clear air turbulence (a commercial air cargo jet recently lost an engine over Colorado due to mountain wave turbulence), downbursts (often called wind shear, the cause of several crashes near airports), and elevated rotors (such an event is the likely cause of a United flight nose-diving into the ground at Colorado Springs) ETL's suite of lidars, radars, and radiometers will be used in conjunction with NCAR's aircraft and computer models to better observe, understand, and predict such hazards. ETL has already co-authored a guide for pilots explaining the hazards, visual clues, and possible corrective actions The observation program is scheduled to begin in late 1996 in Colorado, moving into other regions in subsequent years.

Winter Icing and Storm Project (WISP)

ETL has been a leading participant in this interagency, multi-year research program ETL has demonstrated the ability to provide "nowcasts" of dangerous aircraft icing conditions in winter clouds along the landing glideslope at airports, using a combination of several new ground-based remote sensors (radiometers, ceilometers, and wind/temperature profilers).

The icing of aircraft in flight is the most significant weather-related hazard: more lives are lost because of aircraft icing than any other weather-related hazard Remote sensors, such as those being developed at ETL, show excellent promise in mitigating this hazard. Relevant observational tools developed at ETL include a state-of-the-art cloud-sensing Doppler radar with dual-polarization capability and also multi-channel, microwave radiometers that detect integrated amounts of supercooled liquid water. To date, research in this program has shown how the unique polarization features of the ETL cloud radar can distinguish and differentiate between rain and hail in potentially hazardous clouds.

Proposed research for FY96 - FY98 will exploit these polarization techniques to identify layers of supercooled liquid water that present the greatest hazard to aircraft Specifically, the next research goal is to determine the hazard detection performance as well as the false-alarm rate for these new radar polarization techniques.

Plans are to conduct cost-effective, local experiments near Boulder during the next two winters followed by a larger effort in the Milwaukee-Chicago metro area during FY98.

Cloud Radar

ETL is producing six autonomous, vertically-pointing, cloud-sensing radars for DOE's and NOAA's climate research. However, these radars are functionally identical to the U.S. Air Force's AN/TPQ-11 radars that were deployed at military air strips in the late 1960's. Those radars, while very helpful to controllers in vectoring aircraft and establishing holding patterns, were abandoned because of short lifetimes (typically only a few days!). Our design has a lifetime of 2-3 years, and modern technology has reduced the cost dramatically. FAA and the Air Force will be interested in these new cloud radars to heighten operational safety at airports under cloudy conditions. Several private companies have expressed interest in commercializing the ETL design.

4. Air Resources Laboratory (ARL)

A key area of research for the Air Resources Laboratory focuses on atmospheric turbulence and

diffusion. Three specific projects concerning volcanic ash dispersion, wind profiling, and aircraft wake vortices have immediate impact on flight safety and are summarized below.

Prediction of Volcanic Ash

An ash cloud drifting hundreds to thousands of kilometers from an explosive volcanic eruption poses a potential hazard to flying aircraft. The ingestion of volcanic ash by jet engines has caused engine damage and, in some cases, failure. Also, the abrasive effects of ash have damaged aircraft exteriors. The ash cloud from the December 1989 eruption of Redoubt Volcano in Alaska was encountered by aircraft in west Texas 55 hours after the eruption - in excess of 5000 km from the volcano. The September 1992 eruption of Mt. Spurr in Alaska produced an ash cloud that was detected by satellite for over 5000 km to the northcentral and northeast U.S. where it caused a major disruption in air traffic. Similar traffic disruptions have happened more recently following eruptions of Rinjani, Indonesia in June 1994, Rabaul, Papua New Guinea in September 1994, and Klyuchevskoi on Kamchatka Peninsula in eastern Russia in September-October 1994. The number of volcanic eruptions has probably not increased these last few years, but the recent emphasis on aircraft safety and the threat of ever increasing economic losses has prompted a much closer awareness of each potentially hazardous volcanic event.

A 1988 Memorandum of Understanding between the National Oceanic and Atmospheric Administration and the Federal Aviation Administration, along with a 1995 inter-departmental National Plan for Volcanic Ash Reporting and Warning, assigns NOAA the responsibility for issuing volcano hazards alert messages as warnings for aircraft operations following any eruption, globally, where volcanic ash has reached flight levels of about 6 km or higher. The message gives the most recent information on the volcanic eruption and the location of the volcanic ash cloud based on ground observer reports, pilot reports, and satellite imagery. In addition, the message also includes charts of the extended forecast of ash cloud locations using the time dependent 3-dimensional Volcanic Ash Forecast Transport And Dispersion (VAFTAD) model developed by ARL.

VAFTAD focuses on aviation operations by forecasting a visual ash cloud location in time and space. VAFTAD is run at ARL and is applicable globally using National Center for Environmental Prediction (NCEP) gridded meteorological forecasts which are updated four times daily. The model can be run at any time by authorized U.S. and foreign government users who "login" through the Internet to a workstation at ARL. (The model is also currently run in test mode or for actual eruptions by the national meteorological services of Canada, Australia, and New Zealand.) Screen-prompted model input requests include a run description, geographic region (anywhere in the northern or southern hemispheres), volcano name, location, summit height, eruption date-time, eruption duration, and ash column top height. Within about 5 minutes of user login, output charts of the forecast visual ash cloud are automatically phone-faxed to the user. In addition, charts are then made available to the public, by the NCEP, over weather information facsimile distribution systems, the world area forecast (WAF) system, and the Internet.

Wind Profiling in Alaska

ETL has teamed with the National Weather Service (NWS) and the Forecast Systems Lab (FSL) to begin converting full-scale, operational 404 MHz radar wind profilers to NOAA's new operating frequency of 449 MHz. Operational radar wind profiling technology was originally perfected at ETL before being transferred to FSL. The change to the new frequency was

necessitated by the potential for interference with international Search And Rescue (SAR) satellites using the same band. A wind profiler, originally installed in Homer, Alaska to better assess the trajectory of volcanic ash plumes from frequent Alaskan volcanic eruptions, will be converted to 449 MHz and two new profilers added. This data is important to NWS in defining the wind fields that transport ash clouds. Knowledge of winds aloft provided by these profilers also helps FAA select trans-continental flight levels for best fuel efficiency and smoothness of ride.

Aircraft Wake Vortices

For many years, the ARL Field Research Division (Idaho Falls, ID) has conducted studies of the magnitude, persistence, and motion of the vortices left by commercial and some military aircraft. A test range on the Idaho National Engineering Laboratory reservation is instrumented with tall towers carrying meteorological instrumentation and photographic equipment to record the wake vortices left by an aircraft flying between them. Studies of this kind have provided critical information used by the Federal Aviation Administration to specify, for example, safe distances for small aircraft to land or takeoff after larger aircraft.

As a result of the continued attention, and in recognition of gaps in current understanding, the entire issue of aircraft wake turbulence was re-addressed during 1994.

A reanalysis of data previously obtained by FRD was sponsored by FAA. The reanalysis focused on the relationship of vortex demise with ambient atmospheric turbulence. In parallel activity, new studies were sponsored by FAA in support of aircraft wake turbulence avoidance and enhanced airport traffic capacity. DOT, FAA, NASA, and NOAA have formed a technical advisory group to formulate plans and review proposed research aimed at resolving the knowledge gaps.

II. The NOAA National Weather Service

The National Weather Service provides warnings, forecasts, flight planning information, and other services for the safe and efficient aviation flight operations for U.S. airspace and global flight planning forecasts and data. These functions are accomplished through NWS Research and Development Programs, Facilities and Equipment Programs and New Programs described below. Information and Service functions managed at all NWS operational levels are also summarized.

Research and Development Programs

Aviation Weather Analysis and Forecasting---developing products in areas such as icing, convective activity, turbulence, ceiling/visibility, and freezing precipitations. Development organizations include NOAA's Forecast Systems Laboratory, National Center for Atmospheric Research, MIT Lincoln Laboratory, National Severe Storms Laboratory, and several universities.

The Kansas City Aviation Weather Center's development of national aviation products (for example, graphical icing, turbulence, convective activity, ceiling and visibility products) for operational forecast testing. The FAA supports the NOAA Forecast Systems Laboratory and the Center's development efforts.

The Alaska Aviation Weather Unit develops regional and local graphical guidance products in coordination with and by assistance of the FAA.

Additional projects involve Aeronautical Hazards Research (e.g., mountain rotor), and Wake Vortex Separation Standards.

Facilities and Equipment Programs

The Automated Weather Observing System (AWOS) is jointly managed by FAA and NWS to provide automated observations at airports of such phenomena as temperature, dew point, wind velocity and direction, ceiling, visibility, precipitation and lightning/thunderstorm activity. 431 FAA systems have been procured, of which 372 have been installed and 35 commissioned. AMOS will replace human observers at selected FAA sites.

WSR-88D (NEXRAD) is a tri-agency (Departments of Commerce, Defense and Transportation) procurement. NEXRAD systems in the contiguous 48 states will be used by the FAA to provide Doppler weather information for enroute controllers in Air Route Traffic Control Centers via the Weather and Radar Processor (discussed below). NEXRAD replaces weather currently provided

by aging long range radars thereby allowing for their eventual decommissioning. FAA systems are also being procured for Hawaii, Alaska and Puerto Rico. These "offshore" systems will provide information directly to meteorologists in Weather Forecast Offices and in the Alaska Center Weather Service Unit 161 systems are being procured (117 NWS, 12 FAA, 26 DOD, and 6 joint use) of which 134 have already been delivered.

Terminal Doppler Weather Radar (TDWR) systems are being procured (45 for operational purposes and 2 for support) to provide wind shear detection and prediction, as well as capacity planning capability at "high risk" airports. High risk airports are with high operations levels and thunderstorm frequency Six systems have been commissioned and 3 other (Charlotte, Washington National and Atlanta) closed. Most of remaining systems will be delivered in 1996. Some adjustments for specific cites (e.g., New York and Fort Lauderdale) remain to be solved before they become totally operational.

The Low Level Wind Shear Alert System (LLWAS) is an anemometer-based wind shear detection system which has been deployed successfully for over twenty years. Numerous systems are targeted for a sustainment program that involves moving and/or replacement of aging equipment. Eight sites (Denver, Dallas-Ft. Worth, New Orleans, St Louis, Chicago O'Hare, Atlanta, Orlando, and Tampa) will integrate an improved and expanded LLWAS with TDWR. These systems will provide the highest level of wind shear protection.

New Programs

The Airport Surveillance Radar-Weather Systems Processor (ASR-WSP), a Doppler radar addition to currently deployed ASR systems, provides capability similar to TDWR but at significantly lower cost. The ASR-WSP is planned for 33 airports and to be operational beginning in 2001.

The Integrated Terminal Weather System (ITWS) is being developed to be installed at all 45 TDWR sites. This system will integrate inputs from all terminal weather systems, as well as NEXRADs, for supervisors' and traffic managers' display. Competitive procurement will take place in fiscal year 1996 with the first operational system installed in 2001.

The Weather and Radar Processor (WARP) will perform two primary functions. The first is to replace the currently leased Meteorologist Weather Processor, which provides information to meteorologists in en route centers and the FAA command center. The second is provide a mosaic picture of NEXRAD information on aircraft controllers' displays in the enroute centers in the same coordinate plane as air traffic is portrayed. WARP is entering the competition phase now with the first operational system projected for 1998.

Both WARP and ITWS provide growth capability for many of the products currently in R&D

Information and Service Functions

Information and services are prepared and managed at all National Weather Service operational levels. These provide:

(a) global flight planning forecasts of upper winds and upper-air temperatures and amendments, jet streams, and tropopause heights;

(b) backup of the United Kingdom's responsibility for same data, both designated by the International Civil Aviation Organization;

(c) forecast and monitor service for volcanic ash cloud movement;

(d) significant flight planning charts for approximately 3/8 of the World;

(e) aviation warnings for the National Airspace System and U.S.-controlled international airspace;

(f) general aviation warnings for the National Airspace System;

(h) general aviation specific domestic route forecasts over the contiguous U.S. and for selected international routes over the Pacific;

(i) forecasts for airports in the U.S. and U.S.--controlled international airspace;

(j) required local airport advisories for weather hazards for ground operations;

(k) direct (on-site and real-time) weather support and consultation to FAA facilities managing air traffic in the National Airspace System and U.S.--controlled international airspace;

(l) direct weather consultation and advice to Air Traffic Control System Command Center;

(m) meteorological training review, instruction, and certification at the FAA Academy;

(n) flight documentation services for international flights;

(o) television show for the Rural Alaska Television Network about meteorological forecasts and education for aviation and marine interests;

(p) communications system, contracted for FAA, used to receive and disseminate global data internationally for 2/3 of the World;

(q) aviation weather seminars and weather training programs for pilots, training and certification of all NWS and FAA pilot weather briefers, publication of educational material, and liaison with State aviation program; and

(r) weather support for transportation safety investigations and proceedings of the National Transportation Safety Board and supporting the Department of Justice and Federal Aviation Administration involving weather products and/or services.

The above is a brief summary of many of the key activities of the National Weather Service in support of the FAA's Long Term Weather Research and Development Programs. Additional programs include:

- Weather Message Switching Center Replacement
- Meteorologist Weather Processor
- Digital Altimeter Setting Indicator
- Time Code Display

- AWOS Data Acquisition System
- Automatic Lightning Detection and Reporting System

III. The NOS Aeronautical Charting and Cartography

The Office of Aeronautical Charting and Cartography (AC&C) has a long history of working cooperatively with the Federal Aviation Administration (FAA) on various research and development projects. AC&C has conducted research on all phases of real-time and computer-assisted navigation such as the following:

o **Fully Digital Air Radar Traffic Display System (FDAD)**

The FAA was faced with the requirement to upgrade the ARTS system to a digital display. AC&C developed software to translate existing Radar Video Maps (RVM) to a digital format compatible with the FDAD binary file structure. This system will be installed at major TRACONs throughout the United States and has already been accepted at Chicago and Southern California TRACONs. The system will go into final acceptance in New York and Dallas/Fort Worth later this year.

o **Final Monitor Aid System (FMA)**

FMA was first installed in the new Denver International Airport. The system is a very high resolution (+/- 2 ft.) real-time map which allows three parallel runways to be in use simultaneously. AC&C, working with FAA, developed new digital mapping methods and map alignment procedures which were later turned over to Magnavox and UNISYS.

o **Standard Terminal Automation Replacement System (STARS)**

STARS will replace the current ARTS system. AC&C is assisting FAA and its contractor to develop the specifications for this system. Using legacy work done for the FAA's Advanced Automation System (AAS), AC&C advised FAA on the metafile formats which will be standard in the STARS. AC&C has also supplied statistical data on digital chart models, data developed over the year that AC&C has been doing RVM and real-time digital navigation support projects.

o **Instrument Approach Procedure Automation (IAPA) System**

The IAPA system, developed by the FAA, will assist that organization in developing new Instrument Approach Procedure (IAP) charts. AC&C developed chart support models and computations to be integrated into the system by the FAA contractor. In developing the models, AC&C devised new techniques for scanning, warping, coloring and geographically referencing raster maps. AC&C developed fast, cost-effective computerized methods of creating a vertical seamless chart that will allow a person to navigate anywhere in the USA. Digital ground elevation is also merged with the image data. The map is accurate to +/- 150 ft.

o **Instrument Flight Rules (IFR) Standard Symbology Set**

AC&C has worked closely with the FAA and DOT's Volpe Lab in developing a standard set of

digital symbols to be used in the production of IFR digital mapping products. The symbols were created using graphic edit software and can be translated into a number of vector formats, suitable for importing into today's most popular drawing and desktop publishing systems. The accuracy of the symbol set is critical to the depiction of aeronautical features on the digital maps. Failure to properly recognize a feature can be extremely hazardous to air traffic control.

IV Conclusion

In conclusion, Madam Chairwoman, we believe that the cooperation between NOAA and the FAA has been productive in the past and expect that it will improve in the future as we both implement modernization programs that bring the latest science and technology to bear on the critical operations carried out in each agency.

Mrs. MORELLA. Thank you, Dr. Thomas. Any testimony you submit will be put into the record.

Mr. Laynor, from National Transportation Safety Board, we're anxious to hear your comments, sir.

STATEMENT OF WILLIAM "BUD" LAYNOR, NATIONAL TRANSPORTATION SAFETY BOARD, WASHINGTON, DC

Mr. LAYNOR. Thank you, Madam Chairwoman.

As is noted in our paper, the safety board of course does not have any research and development capability of its own. It depends largely on the FAA and folks like those here at the table with me to address some of the needs that are identified in the accident investigation process.

Certainly, the accident investigation and the safety board's recommendation process has had a strong influence in the past on the FAA's R&D programs, as well as the programs of NASA and NOAA. And generally, the response to our recommendations in any of the major areas that have been identified as safety hazards to aviation have been pretty well addressed by those programs.

I was interested in Mr. Poritzky's comments earlier about the accident of the month and the issue of the year and I'm sure we'll probably have more to say about that.

But in some cases, the programs have brought quite a lot of benefits to the aviation safety arena, and in other cases, some of the tangible benefits to the programs that have been underway for some time and are still underway are taking a little bit longer than what we would like, and in some cases, that's understandable.

Some of the past delays that we've seen, in years past, in some of the programs by the FAA, were certainly attributable to the internal coordination problems that were addressed in the panel, the problems between the R&D community—flight standards, the Air Traffic Services and airports—we think that that's getting better and we hope that the integrated product team concept is going to pull a lot of that together.

I might add that some of the past FAA programs have worked pretty well as far as the coordination among the groups. One that comes to mind is the FAA's wind-shear program where the National Center for Atmospheric Research did a lot to pull different elements within the FAA, as well as industry and other government organizations, together on a fairly regular basis to review the progress of the associated programs.

And I think that this has eased the introduction of some of the equipment that's grown out of that program, like the terminal doppler weather radar, very much as it's entering into service.

We believe that any future reform by the FAA, and I might add that the safety board has not adopted any collegiate position on any specific legislation. But any reform has to address the internal coordination, as well as the streamlined acquisition process.

And that completes my statement. Thank you.

[The prepared statement of Mr. Laynor follows:]

Safety Information

National Transportation Safety Board

Washington, D C 20594

7.

Testimony of

Mr. William G. Laynor

Chief Technical Advisor

National Transportation Safety Board

before the

Committee on Science

Subcommittee on Technology

House of Representatives

Regarding

An Industry Perspective of FAA R&D Programs

December 7, 1995

The National Transportation Safety Board appreciates the opportunity to provide testimony regarding the Federal Aviation Administration's (FAA) research and development (R&D) programs.

Unlike most of the organizations represented here today, the Safety Board does not have either the mandate nor the resources to conduct research and development, or to participate directly in those programs conducted by other agencies. However, as the agency responsible for the investigation of accidents involving civil aircraft in the United States, and for representing U.S. interests in aviation accidents occurring in other countries, the Safety Board has a significant role in defining the R&D needs as they relate to enhancements in the safety of the aviation transportation system.

While the FAA's R&D efforts should be directed toward the modernization of the aviation transportation infrastructure to increase efficiency and capacity, safety has and will remain the most important and visible consideration. Accidents of any type that result in loss of life are tragic, especially in terms of the suffering of family and friends of the victims. But, because of our Nation's economic dependence on air travel, major aviation accidents with the potential for large numbers of victims have a profound effect on the entire country, as evident by the media attention and the loss of public confidence in the system. The only possible positive effect from an accident is the actions that have to be taken to prevent future accidents from similar causes.

The Safety Board, therefore, views its safety recommendation process as perhaps its most important responsibility. Almost all major aviation accidents result in recommendations to the FAA, and on occasion to other agencies, and many of these recommendations influence the R&D programs. The Safety Board is in what

some might view as an idealistic position in that its recommendations are in the interest only of safety, and do not have to consider some of the real-world factors such as budget and priorities. While these factors have sometimes affected the timeliness of some essential programs, the FAA's response to the Board's recommendations, including those relating to R&D, has generally been excellent.

Some of the most visible R&D efforts to have stemmed from accidents have included:

- the development of airborne collision avoidance equipment;
- the development of both ground-based and airborne windshear/microburst detection equipment;
- extensive testing of cabin interiors to improve fire safety and crashworthiness of both transport and general aviation aircraft;
- the improvements in ground deicing/anti-icing fluids and procedures;
- the containment of high-energy rotating parts within engine cowlings;
- the development of airport surveillance and ground collision alerting equipment; and
- the issue of human factors as related to both flightcrew, maintenance personnel, and air traffic controllers.

Although all of these areas have been the focus of extensive R&D efforts, the realization of tangible benefits has sometimes taken a longer time than the Board would like. In some cases, these benefits have yet to come.

The development of an airborne collision avoidance system, and finally the required installation of the TCAS system, may best exemplify some of the past FAA problems in bringing an R&D program to fruition. The industry's recognition of the need for an airborne collision avoidance system goes back to the 1956 collision of two large transports over the Grand Canyon. By the late 1960s, industry was sponsoring a flight test program of breadboard equipment and FAA was playing a supporting role. By the early 1970s, there were at least three non-compatible technologies by civil and military organizations. All were technically, but maybe not practicably, feasible. In 1973, the FAA decided to drop the idea of a ground independent collision avoidance system and focus its efforts on a ground-based system with automated data link communication of conflict warnings to aircraft.

It was not until after the 1978 collision of a Boeing 727 and a Cessna at San Diego, California, that the FAA Administrator made a decision to proceed with full effort on the development of TCAS, an evolution of one of the systems being tested ten years earlier. Following nearly 20 years of development in the R&D side of the FAA, a system was then given to Flight Standards to approve for installation in the transport fleet. Having not played an active role in the R&D effort, the Flight Standards certification team was required to re-evaluate the safety of the system and compatibility with the existing ATC system. In 1989, the FAA finally required that the TCAS system be installed in large passenger-carrying transports with an installation schedule to be completed by the end of 1993. Unfortunately, although the system had been in some phase of development for more than 23 years, it was introduced without adequate training of air traffic controllers to inform them of the potential effects of airborne conflict maneuvers on their routine ATC operations.

Today the TCAS is operating well on the large transport aircraft and we are reasonably certain that some accidents, or at least serious evasive maneuvers, have been prevented. However, the effects of a lack of coordination between the various elements of the FAA organization during the development phase was obvious.

Some of the other FAA sponsored R&D programs appeared to be better coordinated. The hazard of a microburst windshear was identified tragically in a Boeing 727 accident at JFK International Airport in 1975. That accident prompted a coordinated effort by NASA, FAA, and NOAA, to conduct the Joint Airport Weather Study program with the National Center for Atmospheric Research (NCAR). The study led to the characterization of the microburst and ultimately with the effort of MIT Lincoln Laboratories and industry to the development and test of the doppler radar system now being used by the National Weather Service, and the terminal doppler weather radar (TDWR) systems being installed in the major terminal areas. An industry/government working group was convened by NCAR to assist in development of procedures prior to the introduction of the TDWR systems. The FAA participants encompassed the R&D, Flight Standards and Air Traffic services and this approach, along with extensive testing at Denver's Stapleton Airport, helped to smooth the system introduction.

Unfortunately, there have been some schedule delays attributable to problems in acquiring the off-airport sites for installation. The Safety Board found in its investigation of a landing accident at Charlotte, North Carolina in July 1994, that the information from a TDWR would have been beneficial to the flightcrew and may have prevented the accident. However, the installation originally scheduled for March 1993

slipped to the end of 1995 as a result of land acquisition problems. However, this problem was associated with the implementation phase rather than the R&D effort.

Similar delays from initial schedule dates have been encountered in the FAA's runway incursion program. The related R&D efforts have pertained to the development of improved airport surface detection equipment, the ASDE-3 radar system, and the airport movement area safety system (AMASS). The Safety Board first addressed the need for improvements to ASDE in a safety recommendation issued in 1973 following a ground collision accident at O'Hare International Airport in Chicago. The FAA at that time responded that there was a concerted effort to improve the performance of the ASDE-2 radars. However, the performance level of the ASDE-2 systems was never elevated to the point that it was relied upon heavily by controllers, and the installations were limited.

The potential hazard of ground collisions received world-wide attention in 1977 after an accident in Tenerife in which 583 lives were lost, the worst aviation accident in history. The Safety Board's concern was further heightened in 1985, when two fully loaded DC-10s nearly collided at a runway/taxiway intersection at the Minneapolis/St. Paul Airport. That occurrence prompted a Safety Board Special Investigation of runway incursion accidents or incidents that culminated in 1986 with 14 safety recommendations to the FAA, some of which re-addressed the need for improved airport surface surveillance.

Shortly afterward, the much needed concept of the AMASS system was developed by the Mitre Company as an adjunct to the development of the ASDE-3

radar. A letter contract was awarded to the ASDE-3 contractor in late 1990, and the planned delivery of operational ASDE-3/AMASS systems was scheduled to begin in 1994. The latest schedule presented by the FAA at a Safety Board public hearing following another runway incursion accident at the St. Louis Airport in November 1994 gives the installation dates for the AMASS at 29 sites between 1996 and 2001. The Safety Board understands that some of the delays are attributable to late changes in system requirements during performance reviews when operational controllers became involved. The Board believes that some delays might have been avoided had there been better coordination with the operational sector earlier in the development and acquisition process.

The Safety Board continues to view the runway incursion problem as a serious safety hazard that must be given the highest level of attention as the other FAA programs to increase system capacity and airport utilization rates proceed.

During this period when everyone recognizes the need to tighten their budgetary belts, the competition for research and development funds will undoubtedly have to grow. However, the cost of accidents is also high and some of the programs that are essential, if we are to maintain safety while increasing the efficiency of our aviation transportation industry, must continue. The Safety Board's accident data show that continued efforts are needed:

(1) in the analysis of turbine engine rotor failures and the development of containment materials to prevent accidents such as the United Airlines DC-10 crash landing at Sioux City, Iowa;

(2) in the study of wake vortices to establish realistic separation standards that assure safety without unneeded compromises to airport capacity;

(3) in the development of an environmental icing envelope that gives consideration to the actual conditions encountered during winter operations and the development of better capabilities for forecasting conditions beyond the airplane's certification envelope;

(4) in the area of human factors and aviation medicine, particularly to assure that adequate consideration is given to the flightcrew and air traffic controller interaction with the increased automation of new aircraft and ATC systems. Additional focus is also needed in the area of human factors in aircraft maintenance programs.

Any discussion of R&D activities would be incomplete without recognizing the rapid growth of technology brought about by the satellite communication and satellite navigation systems. While the Safety Board does not have the depth of resources to be fully involved in this activity, it recognizes the challenges that the FAA will face as GPS is accepted as a primary means for enroute navigation and precision approaches. The early implementation of the Wide Area Augmentation System and the transition to a free flight ATC environment will be an exciting future for the aviation community. It is essential that this activity be well coordinated between government and industry on an international basis involving both the users and the R&D communities.

In summary, the Safety Board's "outside looking in" view of the FAA R&D programs tends to support the findings of other oversight organizations -- specifically that improvements are needed in the coordination of R&D, acquisition, and implementation of new equipment to assure that requirements are compatible with the users' needs, and that participants in the system are adequately trained when the equipment becomes available. This coordination must include all elements within the FAA, as well as other government agencies and industry. The integrated product team concept is a step forward in achieving such coordination.

While the Safety Board has not adopted a formal position on specific proposals regarding FAA reform, any changes that would enhance the ability of the FAA to respond to system growth and to emerging technologies must be viewed favorably. The requirement for coordination between the R&D community, flight standards, ATC, airway facilities and airports must be a top consideration in any future reorganization of FAA.

Mr. Chairman, that completes my statement. I will be happy to respond to any questions you may have.

Mrs. MORELLA. Thank you very much, gentlemen.

Dr. Whitehead, you mentioned in your testimony that the most recent memorandum of understanding with the FAA management is through an integrated product team, with a NASA employee as the deputy head.

NASA will be a full partner in establishing goals and in program planning and program oversight.

Is this the same approach that will be taken for the other six MOUs with the FAA?

And then, also, is there an opportunity for outside review by air space users and outside technical experts for all of the R&D under the MOUs?

I guess that would be seven of them, then.

Dr. WHITEHEAD. Yes. Let me speak specifically about the seventh, the new MOU signed by Mr. Hinson and Goldin.

Because of the importance of that technology program to air traffic, and because of what we've learned in doing cooperative programs with the FAA—and I'll cite also that one of the most successful ones that we learned from was the windshear program, and it has some similar characteristics.

We've gone further in terms of development in IPT, and which FAA chairs and NASA cochairs, on this air traffic technology program, than most of our other programs.

The reason we did that is that one of the things we've learned by some of our—I won't say failures, but lesser successes—is that, for air traffic, if new technology is required or if integration or insertion of technology is going to be required, we need a really good understanding of, number one, what architecture will that technology go into, and number two, whether the requirements for technology to go into that architecture and make sure that the technology that's developed has a way to be inserted.

So we've taken an extra step in this area from—I'll give you an example of another program from a normal cooperative program, to make this truly a joint program in which, from the beginning, all aspects of the program are jointly developed and managed, including technology development.

Other programs under our six number used, like our noise reduction program, for instance, is a program in which we established an FAA-NASA industry group to advise in planning that program.

Once it was planned and the technology development was agreed to, NASA has managed its program and made its investments against that plan.

So, in that case, we managed the program ourselves. We make the investments ourselves, but against a jointly developed plan.

In our aging aircraft program, which is a joint program with the FAA, we developed a cooperative plan that both agencies invest in research and technology in pre-agreed areas, in areas where we had better expertise and that they, and we've made our investments through the agency, but again, against a joint plan.

So we've done a variety of cooperative activities in the best way that we thought they would work at the time.

All of those programs, though, have significant industry, either manufacturer and/or operator, oversight, advisory and review in them.

We did something this year that we've never done before that I think has been helpful. And that is that we had the first joint meeting of the formal advisory committees for the two agencies.

The FAA R&D advisory committee and the NASA Aeronautics Advisory Committee held a joint meeting. One of the consequences of that is that we're going to form a subgroup of that advisory group to provide oversight to the new advanced air traffic technology program that we're going to run under an integrated IPT.

Mrs. MORELLA. Does that also kind of reflect the extent to which the federal agencies would sponsor or perform aviation R&D, work collaboratively to develop specific R&D goals and coordinate?

Is that typical or is that atypical, or what? Are there any other needs for further coordination?

Dr. WHITEHEAD. I think it's the wave of the future. It's not the way we've always done business.

I spent, with my friend Jim Wilson, most of my career in the Defense Department, not in NASA, in research.

We feel in NASA, and I believe FAA and the DoD, to a degree, feel that what's happening to the federal investments in R&D in general and in aviation in particular, and where we see it going is going to require a level of national alliance and partnering and elimination of duplication and a national investment strategy in a priority order in order for this country to maintain a viable R&D program in critical aviation research and technology, both for the civil and military manufacturing segments, as well as for the air traffic aviation system area.

That's why we believe that the national partnership policy is so important and that, because it's a better way to do business and because it's necessary, we'll increase the level of our coordination in our partnerships.

Mrs. MORELLA. And that would be good.

Dr. Thomas, a question for you. Within the last month, the National Academy of Sciences released a report which calls on FAA to assume a stronger role in providing aviation weather services. The thrust of the report is that there has been a lack of leadership in setting priorities for and establishing the programs that are needed to improve weather services for aviation users.

Relative to aviation weather research, the report finds inadequate integration among research programs and inadequate integration with operational programs.

It also notes that a 1977 agreement between FAA and NOAA on development of aviation weather requirements and needed systems has never been carried out in practice, nor has the high-level interagency coordination included in the agreement been put into place.

That's an awful long preface to the question of do you agree with the NAS report that NOAA and FAA should carry out more closely the intent of that 1977 agreement to establish requirements and to coordinate more closely on aviation weather-related R&D?

Dr. THOMAS. I'm not prepared to answer that yes or no today. I have only briefly seen the report, so I cannot comment on that.

Also, because this is heavily an issue that's associated with the National Weather Service, we haven't developed an agency response to that report right now.

I would only say that we do have, I think, some very outstanding examples of cooperation. The weather radar program is clearly, I think, one of them. It's meeting the specifications that the R&D people had indicated through their demonstrations back in—there was a joint Dod/FAA/NOAA project in 1977, based at our laboratory in Norman, Oklahoma, the National Storms Lab. And we're seeing out of that the kind of lead times that we saw in the R&D environment out of the NEXRAD program.

The algorithms are working. Many of the algorithms have transferability. The National Storms Lab has worked on the terminal doppler, also.

So there are, I think, some successes. Now whether the total planning, the systems issues are very difficult. We have had a number of academy reports on NOAA and we have responded. I think there has been a lot of programs and activities that I think are well done.

Part of the coordination is many times within the organizations.

I know in NOAA, we have improved the interaction between the services and the research program a great deal in the last five or six years. We formed a laboratory called the Forecast Systems Laboratory, which happens to be also the laboratory that works most closely with FAA today on how do you develop the weather analysis and observations that are necessary for our weather forecasts, but also our products that could be used in both air traffic control—primarily in air traffic control, but also air safety, both in-flight and terminal effects due to weather.

So we are trying to work with FAA in the sense of trying to fit into their plans as they are transmitted to us and as we can view them, and work with people, say, at the Volpe Center. Or in the Denver area, we have an air traffic control center, so we're working with them in putting systems in front of them for testing to see if this gives them the kind of weather information.

So, as I said, I think there is a lot of cooperation, but I would have to look at the report and we'll get back to you on that.

Mrs. MORELLA. Yes. The report says—I think it says that FAA should take a stronger lead when it comes to aviation weather issues.

It would be interesting in the response of the agency to that report. But you also pose another question about, through what mechanisms do the various federal agencies which conduct aviation R&D, how do they find out what the others are doing?

Is there any mechanism or procedure, process?

Dr. THOMAS. Well, the way we do it in NOAA is a lot of contact between the relevant parties.

We have a number of internal mechanisms in NOAA for the operations and the research to get together and push against each other.

You have a set of requirements you like to meet. But, to a major extent, you've got to look at what the technology, what the science will allow you to do.

And so we push that together to come up with the best approach and then we try it out and see how it works.

And given the state of the technology today, there's really in some ways a blurring between R&D and the operations in many

ways. We run a number of R&D systems that provide operational data today. And it's in testing that that we develop our specifications in a continually evolving way.

I know R&D managers that are laboratory directors. In NOAA, we base a lot of R&D on federal laboratories and they work with their counterparts in R&D.

So a lot of our weather research is done that way. And then we bring in the academic community as a part of a project. So when they talk about projects with NCAR, we have some where we're working in the context of NCAR's design and there are other projects where NCAR works in a design that's put together, say, by one of our laboratories, or FAA.

Mrs. MORELLA. Do you want to comment on that, Dr. Whitehead, in terms of coordination?

Dr. WHITEHEAD. Yes. Thank you. The first thing I'd say about coordination is I think we've recognized it now and I believe everyone has, that the coordination and the customer, if you will, interface is a daily business. You have to do it every day.

We have a number of formal mechanisms with FAA and DoD. I'm a permanent member of the FAA R&D advisory committee. Likewise, Dr. George Donahue, my peer, is a permanent member of my Aeronautics Advisory Committee and a formal mechanism.

We also have a NAA/FAA coordinating committee that stretches that coordination down into the organization and also across the services.

We spend a lot of time listening to the people that were on the panel before us and their organizations and others like RTCA, in which we put participants on task force three and other task forces.

We have with FAA colocated field centers. FAA has a field center at our Ames Research Center and at our Langley Research Center. Those have been in place since the '60s.

So we have FAA on-site at our performing laboratories full time. We have done a number of studies together.

But primarily, there are a number of formal and informal mechanisms that you have to work every day. To give you a measure of the importance that we've placed on these partnerships and this coordination, we're reorganizing the Office of Aeronautics in Washington, driven by the national performance review requirements to get 50 percent smaller.

One of the organizational units, though, that we've put into the new organization is called the Alliance Development Office. It's led by a senior executive, our most experienced manager at headquarters now, and its full-time job is to see that both our industry, our university and our other agency alliances and partnerships are worked on every day as a primary strategy for the way we do business.

So we think that the emphasis on making sure that these coordinations happen on a continuing basis has to grow.

Mrs. MORELLA. I'm sure it does. Did you want to make a brief comment, Dr. Thomas?

Dr. THOMAS. Well, I would just re-emphasize that, particularly through our National Weather Service that provides the daily weather information to the FAA, as well as meetings between Dr. Friday, who's head of the Weather Service, and the FAA, in terms

of their operation. There's an enormous amount of information on what are the day-to-day issues that come up in providing operational services, in NOAA's case, the weather reports, forecasts that are necessary for air traffic control and safety, and from the FAA's side, how do they use that information to deliver their product.

Mrs. MORELLA. Obviously, there's a need.

Well, Mr. Laynor, you thought I forgot about you, didn't you? I don't want you to feel that way.

In your testimony that you submitted, you indicate several R&D areas which, for safety considerations, deserve attention.

Does FAA's current R&D investment assign an adequate level of priority to the research areas that you have identified?

And then, continuing on, does NTSB have an opportunity to influence the specific objectives of FAA R&D programs that focus on those subjects?

Mr. LAYNOR. Well, I think so, Madam Chairwoman. In fact, we did become a bit concerned about how the tightening of the government budget was going to affect a number of the ongoing FAA R&D programs that addressed some of the issues that we've seen in the past.

Back in September, we invited Dr. Donahue and his staff to brief the safety board on the future impact on many of the programs. I believe, as a result of that briefing, that we were relatively satisfied that the programs were going to continue and that there would be very little impact.

That involved the activity at the technical center, along with a lot of the activity that the FAA has ongoing with NASA, in areas like wake vortex turbulence and there was still some windshear activity going on at that time.

Engine containment is a major issue that we think has to be continued. It was mentioned earlier about the environmental icing problem. That program has been ongoing at the tech center and as a result of some recent accidents, there's probably been some change in focus that we think is appropriate and that will also involve NOAA and NASA.

So I think the answer is yes. We're satisfied that they're being given attention.

Mrs. MORELLA. Great. Good. Let me ask you also, Mr. Laynor, in the previous panel, you heard Mr. Poritzky suggest that FAA's senior management needs to become more closely involved with making the decisions, those tough decisions, that is, on system modifications and new technology improvements.

Do you agree with his assessment? And I might want to open that to Dr. Thomas and Dr. Whitehead, if they would like to comment.

Mr. LAYNOR. I partially agree. The safety board can be idealistic, of course, in the context of the recommendations and accident investigation because we're not really confronted with trying to determine where the budget and where the funds are coming from to address any program.

But, in my observation, the accident causation, aviation has quite a history and there's seldom anything new.

So most of the R&D programs that are underway already are tending to address a lot of the issues as they arise.

I mentioned the environmental icing area. The research into atmospheric icing and how to develop better forecasting techniques and better define the aviation certification icing envelope, is not a new issue, and it's an issue now that is being given a little bit more focus as a result of an accident in Indiana a year or so ago.

One of the major issues that the safety board has been addressing for a long time is the runway incursion issue. And a lot of the programs that are ongoing within the FAA, and particularly the programs that interest the user groups, the airlines and the airports, is intended to increase capacity in the system.

We believe that certainly solving the runway incursion program and solving some of the separation standards issues with the wake vortex are going to have to be accomplished to address those other goals.

Mrs. MORELLA. I'm going to ask you all just one final question in the interest of time. I've kept you long enough. And again, the idea that we may direct further questions to you for responses as we move forward.

And that is, if you had a magic wand and you could bring about any correction, remedy, progress, what would you assess as being the greatest problem or challenge that you would want to correct, and in what way would you do it?

Do you want to try it, Dr. Whitehead? I know you haven't had any chance to think about it. But I'm just curious about how you see, what kind of a problem do you see that you would like to address?

Dr. WHITEHEAD. It's a very good question. I think I do have an answer. I've thought about it. And I'll go back to the dual role that we have with FAA as a customer because they operate systems and regulate aircraft and they also do research.

We walk sometimes a tedious line between our partnership interface with the research element at FAA and some of the desires of the operational side for us to help on things that could create a situation in which we end up operating directly with those elements independent of the research element.

We have to be very careful of that.

I suppose that if I wished for anything from a NASA perspective, it would be for a clear, unified strategy and vision for FAA and its requirements and its needs, so that we're an eager partner. We think we have a lot to offer in partnerships. We have successes, but so that we wouldn't both make mistakes because of lack of clarity of what we're all trying to do, which is to improve the aviation system and its safety and its environmental compatibility.

Mrs. MORELLA. So you see a clarity of the mission and a vision and a strategy that would follow.

Dr. WHITEHEAD. Yes. We make many mistakes at NASA, I'll have to admit. But they are often mistakes generated by trying to help, but not quite understanding what it takes.

And we get out in front of our customers and, because we're technical enthusiasts, we show what's technically possible without understanding what it takes to insert the technology, for instance, or where it fits or what it fits.

Mrs. MORELLA. So FAA should give you the total picture.

Dr. WHITEHEAD. FAA and their customers, the user community, the manufacturers whose airplanes have to be certified. It's not bilateral, but it's the people represented by the earlier panel and all sort of—in the air traffic, it gets down to what's the architecture and what pace are we going to pursue that architecture on.

But that same vision needs to be across the board.

Mrs. MORELLA. Good point.

Dr. Thomas?

Dr. THOMAS. Well, that's a very good question and a very difficult question, I think.

I guess I'll just pick out one area. I think that, as we get into the more technically complex world where we are very dependent on systems, on the whole issue of how do you go about planning and developing and eventually implementing fairly large technical systems with the interaction with human beings, is an area that I think we all have to learn more cooperatively.

And I think that that's one that I've been hearing from the earlier panel. It's one that we have some experience in NOAA in system development.

Clearly, the federal regulations are difficult to work with and need to be clarified.

I think in terms of vision or defining it, it seems to me that you need a lot more hands-on work on trying to put them together so that there's an interaction between the user and the person, the group developing the systems.

And so, I think that's an area that needs attention all over, and how do we fly before we buy? How do we reduce the risks? How do we go about knowing that we're coming down with a system that's the most cost-efficient one and delivers the product?

So I think the issue is a combination of how do you do business in the Federal Government with do we know what our customers really want?

And putting those together I think is a difficult problem for everyone.

Mrs. MORELLA. It sounds like total quality management, right.

Mr. Laynor?

Mr. LAYNOR. Well, I think that part of it certainly is in the difficulty in planning a long-range program. I think Mr. Fleming hit on it a little bit.

You try to plan a program that's going to span 10, 15 years before it comes to fruition, with uncertain budgets, changes not only in the top management, but oftentimes in the middle management, and along with that come changes in the requirements as is seen by the new management.

I think that's very difficult.

So I guess the answer would be to create stability in both the management ranks, better coordination within the elements and also some assurance that you could plan ahead, budget-wise.

Mrs. MORELLA. I want to thank the three of you very much for being here and being so patient and for giving us the benefit of your experience, as well as your thoughts for the FAA R&D programs.

Without objection, the Subcommittee will accept any additional comments from our witnesses or any other organizations that would like it to get into the record, relative to the topics that we have discussed today, and we will accept it.

The record will be open for about two weeks. Thank you.

The Subcommittee meeting is now adjourned.

[The hearing was adjourned at 12:10 p.m.]

[The following material was received for the record:]

STATEMENT OF

CAPTAIN J. RANDOLPH BABBITT, PRESIDENT
AIR LINE PILOTS ASSOCIATION
BEFORE THE
SUBCOMMITTEE ON TECHNOLOGY
OF THE COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES
DECEMBER 7, 1995

AN INDUSTRY PERSPECTIVE OF FAA R&D PROGRAMS

Madam Chairman, I am Randolph Babbitt, president of the Air Line Pilots Association (ALPA). ALPA represents the interests of 44,000 professional airline pilots flying for 37 airlines. We appreciate the opportunity to present our views on the issue of FAA's research and development programs.

GENERAL

In 1994, the major, national and some regional airlines combined to create revenues of $82.2 billion, or approximately 1.4 percent of the Gross Domestic Product, and employed 511,000 people. Billions more in revenues and hundreds of thousands of others are employed in related industries which support the aviation industry or are greatly affected by it, including maintenance, service and parts providers, hotels, restaurants and so forth. All of these jobs are reliant on the provision of safe and efficient air traffic control services and other functions performed by the FAA. Indeed, we know of no other sector of the U.S. economy which is so dependent on the day-to-day, even minute-to-minute, effectiveness and efficiency of a single federal agency as the aviation industry is upon FAA. No aircraft land or takeoff at towered fields without an FAA clearance. No aircraft are allowed to fly under instrument rules without such a clearance. All indicators point to the continuation of this government/industry relationship into the foreseeable future.

For that reason, it is imperative that the FAA be well managed and provided the resources it needs to safely, effectively and efficiently provide air traffic control services and accomplish all activities within its purview. Legislative initiatives are now pending in the House and Senate to reform FAA, make it semi-independent, create an oversight board comprised of government and industry representatives, take the Aviation Trust Fund off budget, reform personnel practices and make other improvements. We believe that these efforts, if implemented, will have a very positive effect on the FAA's performance agency-wide, which will correspondingly improve its R&D success rate.

We sound a note of caution to this Subcommittee about the ongoing loss of highly-qualified individuals from the ranks of FAA's engineering, scientific and technical personnel and believe that plans must be established and implemented to ensure that an appropriate level of staffing is available, in spite of other government work force reductions, to perform necessary R&D. Failure

to do so dims the prospects of the entire U.S. aviation industry, including the future of its employees, and its place of pre-eminence in the world.

Following are our answers to the four questions posed in the hearings' charter:

Q1. Will the FAA's research and acquisition plan meet the validated operational requirements of the NAS considering the activities of all agencies which fund aviation related R&D?

A. Generally, the FAA's plan does focus attention on the areas of greatest importance to aviation. Needed, however, is greater industry input throughout the R&D process, from planning to full implementation, to help ensure that (1) the end beneficiaries agree with the FAA's priorities and (2) the agency is encouraged to keep its commitment to develop and implement projects within the allotted time. Again, planned FAA reforms may prove very beneficial in this regard.

Q 2. How does the FAA incorporate the expertise of pilots, corporate, regional and major airline management, controllers, technicians and other industry experts in establishing the operational requirements of the NAS and developing long-term research and acquisition goals?

A. ALPA is a member of the FAA R,E&D Advisory Committee which is responsible for providing input to the agency's R,E&D plan. We are generally satisfied with our ability to influence which projects receive priority. Our chief concern is that the FAA as it currently exists is incapable of effectively shepherding the projects through to a timely and cost-effective completion. Further, FAA's success is also dependent on actions taken by its congressional overseers -- a strong commitment to R&D by congress coupled with an appropriate level of FAA accountability can make a significant difference. We also note that certain research projects, like the one on aircraft icing following the October 1994 ATR-72 accident at Roselawn, Illinois, are instituted only after an accident has occurred. If industry were given greater opportunities by FAA to assist in R&D planning efforts, it is our opinion that certain items with the potential for significant industry impact would be addressed in a more timely manner.

Q 3. How does the FAA coordinate its R&D efforts with other government agencies which sponsor aviation-related R&D? Is the coordination effective in gaining synergies of effort and resources while avoiding costly duplication?

A. Our experience is that the FAA does cooperate fairly effectively with NASA on a number of R&D projects of interest to ALPA. There may be opportunities for the FAA to increase its level of coordination with DoD, the National Highway Transportation Safety Administration (NHTSA) and others. We are not of the opinion that all synergies have been realized and no unnecessary duplication is taking place.

Q 4. What has been the effect of FAA's most recent reorganization and its introduction of Integrated Product Teams (IPT)?

A. The success of these IPT's is still to be determined, in our opinion. However, we certainly agree with the concept of focusing efforts on specific projects with dedicated staff. We commend to the Subcommittee the concept of instituting the best and most effective R&D practices from the private industry. Freeing FAA from its current rigid personnel practices should also be beneficial.

SPECIFIC R&D PROJECTS

Following are our comments on specific areas of aviation research and development, listed in alphabetical order, most of which reference projects identified in the 1995 FAA Plan for RE&D (the Plan).

<u>Advanced Materials/Structural Safety</u>

There is a lack of information and standards for certifying aircraft made from composite and advanced materials. Advanced composite material structural safety research must focus on acquiring the necessary knowledge to support certification and airworthiness regulations. There is also a need for crashworthiness structural safety and ways to increase protection for both occupants and crew during an accident.

Research in the advanced materials area must focus on: the mechanical properties of composite and other advanced materials, damage tolerance, environmental impacts, joints, and other structural or fatigue issues, the development of standard process characterization procedures, control criteria and production readiness.

In the area of structural safety, experimental and analytical research efforts must be developed to create guidelines and performance criteria that ensure continued aircraft structural airworthiness. These efforts should help reduce occupant injuries and fatalities during a crash.

Aircraft crashworthiness research should focus on three main areas: airframe structures, aircraft interiors and analytical modeling/computational methods. In the structure area, analysis of the crash environment, aircraft fuel systems, and structural components needs to be conducted. Seat/restraint systems and interior furnishings must be analyzed in the aircraft interior area. Analytical modeling/computational methods must be used to develop improved structural, occupant and seat/restraint systems.

Included in the analytical modeling/computational methods area is the need for updating an existing software package used for airframe structural analysis (i.e., KRASH). This software package needs to be upgraded to include the predictive effects of aircraft impacts with water and soft soil. In addition, by the next century an advanced replacement for the KRASH computer model must be developed.

There is also a need for varying test conditions for different aircraft types and sizes to include all-metal commuter aircraft, aircraft manufactured with varying amounts of composite materials and

jet transports in the current fleet. In addition, testing must also be conducted on empennage and wing fuel tanks, auxiliary fuel systems, overhead bins and advanced, energy-absorbing seats (in conjunction with NASA).

Aging Aircraft

Each aircraft used to carry passengers and/or cargo for hire has a design service life which establishes its initial operational life expectancy. This service life is established during the initial certification of the aircraft. Due to economic considerations, aircraft manufacturers have determined that these service lives can be extended through suitable testing and evaluation of critical aircraft structures. The FAA has established a comprehensive maintenance and inspection program with enhanced data gathering and analysis to identify potential aging aircraft problems.

Following the 1988 aircraft accident involving Aloha flight 243 near Maui, Hawaii, industry, along with the FAA, began working on an approach to the problem of aging aircraft to assure the continued airworthiness of the air transport fleet. Due to the urgency of the problem, the original work focused on those aircraft that were originally certificated prior to 1970, and therefore, most susceptible to structural problems associated with aging.

While the aging-aircraft work on those aircraft is almost complete, there is the succeeding aircraft fleet that was certificated after 1970 and also the future aircraft fleet for which continuing airworthiness is, or will be, of concern. The requirements for responding to these concerns on the structural integrity of these aircraft fleets should be uniformly applied to assure the safety of the traveling public.

To address aging-aircraft structural design problems, improved methodologies and test data are needed. Areas where research is needed include corrosion effects on fatigue and fracture, the effect of single and multiple repairs on airframe structural integrity, and maintenance practices and training. Existing and emerging nondestructive inspection (NDI) equipment and methods need to be evaluated in relation to their capability to detect structural defects.

In addition, analytical tools and models to assess commuter and transport aircraft structural integrity and repairs need to be developed along with technical data on widespread fatigue damage and the corrosion fatigue interaction. Technical data for flight and ground loads that can be used for structural design, analysis and certification are also required.

Multi-site-damage effects on residual strength and residual strength predictive methodologies must be validated. Factors affecting fatigue and airframe design fracture resistance must be studied.

A methodology must be developed for determining structural design and fatigue loads on small aging aircraft. In addition, repair procedures for commuter aircraft must be studied. A commuter aircraft operator's handbook on aircraft corrosion is needed. Also, with composite materials in

increasingly greater use on regional and jet transport aircraft, specifications must be developed for composite-to-metal repairs.

Finally, work needs to be continued within the FAA's National Aging Aircraft Research Program (NAARP). This program has combined the talents of government, academia, and industry in achieving research and development goals in many areas including inspection and structural integrity.

Aircraft Accident Survival

We generally agree with FAA's aircraft fire-related research as contained in the Plan and believe that it may lead to reduction of fatal fires onboard aircraft. However, other areas needing R&D are not addressed sufficiently or at all. The FAA should make a major effort in the research of aircraft design and its influence on emergency evacuation. This should address everything from the start of the evacuation to the point the passenger reaches the ground, including all major types of accident scenarios. The research should delve into ways to preclude unnecessary injuries related to interior items and components falling on passengers upon the aircraft's impact with the ground during survivable collisions.

More research on impact survival is also needed in the area of aircraft ditching. The certification criteria contained in FAR Part 25.801 is woefully inadequate and may only become apparent in the event of an emergency at sea, with hundreds of lives at stake.

We agree with the FAA that there should be a multi-faceted and redundant approach to fire safety in aircraft. This should address making all of the interior materials of very low heat-release potential. Though they serve excellently in the role of maintaining pressure vessel structural integrity, the aircraft cabin windows provide an extremely poor thermal barrier. There is great promise for achieving zero-heat-release materials if research efforts are continued. Such efforts with windows may also be productive in delaying fire penetration into the cabin.

Continued efforts to make a functional, error-proof, water-spray fire protection system for the cabin interior are also needed, as the research appears well established to achieving an effective system at a reasonable weight. This is the type of redundancy in design that will succeed in saving lives.

Fuselage fire-hardening efforts must be expanded to include all the scenarios of accidents that cannot be prevented, including tank ruptures and structural breaks in the structure that have fuel lines across them. Detection and suppression of flammable and volatile vapors should be emphasized.

In summary, we recommend that the FAA expand its efforts to include the elimination of fuel spills in or near the fuselage, improve flammable vapor and early smoke detection, provide full cabin fire suppression and research aircraft structural response to controlled water impact.

Aircraft Atmospheric Hazards

Methods for the in-cockpit reactive detection of critical icing must be developed and implemented. Of particular interest is the ultrasonic equipment being developed by Intertechnique in Toulouse and tested at Edwards on the ATR during March 1995 tests. This equipment is designed to measure type of coverage (liquid, slush or ice) and thickness (in millimeters). Properly located, this type of device could provide an objective measurement of ice impingement both at and aft of the protected areas, numerically quantified and annunciated. Such data in the cockpit would give the flight crew positive warning of an icing exceedance encounter. This information would remove the subjectivity of judging icing severity from the cockpit.

Work should also continue to research the concept of aerodynamic monitoring currently being developed by B.F. Goodrich Aerospace.

Methods for the in-cockpit predictive detection of critical icing must be studied and developed. Such work has been proposed by the Cold Regions Research Laboratory in Hanover, New Hampshire. Two technologies which have potential as a predictive detection system are multi-spectral radar and multiple field of view (MFOV) lidar. Radar has the ability to penetrate cloud masses; lidar has the ability to detect cloud droplet spectra. As both have disadvantages as well, it may be necessary to consider different implementations of these technologies or fusions of multiple technologies to attain operational utility.

ALPA is pleased that the FAA plans to screen and assess commuter class aircraft with potential susceptibility to icing-induced tailplane stalls (ICTS). However, this test plan appears to be outdated and has been superseded by the FAA's efforts of the Phase I through III plan currently in place. This three phase plan was implemented shortly after the ATR-72 aircraft accident over Roselawn, Indiana in October 1994.

ALPA has been participating with industry and FAA in the above program. It is ALPA's understanding that Phase III of the test plan will greatly exceed ICTS and will address all icing-induced handling and performance issues. Industry must screen and assess commuter class aircraft susceptibility to all icing induced control problems. ALPA is anxiously awaiting the outcome of Phase III of the program.

Recently an effort was initiated by the FAA's Flight Standards branch to provide holdover times for certain ground anti-/de-icing fluids in freezing drizzle and freezing rain conditions. In spite of the fact that these fluids may work satisfactorily on the ground for removing or precluding ice formations, current FAA certification requirements do not address aircraft inflight operations in such conditions.

FAR 25, Appendix C clearly addresses only those conditions well short of freezing precipitation of any kind. Therefore, ground operations in freezing precipitation conditions is completely acceptable; however, once an aircraft becomes airborne, it exceeds its certification criteria. Furthermore, with no testing protocols designed for such conditions, no information on

performance and handling qualities exists in this flight regime. Therefore, investigations into ground anti-/de-icing technology must continue. However, any assessment must be conducted so as to take into account any aircraft's certificated operating envelope. Flight operations into these particular areas must be prohibited until adequate performance and handling qualities can be assured.

Since no manufacturer plans to build an aircraft capable of operating in every possible icing environment, the importance of identifying hazardous icing environments through forecasting and in real-time is obvious. Recent work on a methodology by the meteorological community has resulted in interpretive software algorithms which could give airline meteorologists, dispatchers, and pilots more information on hazardous icing than was previously available. This technology, along with the effective utilization of new satellites and new generation weather radar must continue to be developed, and its implementation must be funded.

Lastly, the validity of FAR Part 25's Appendix C must be re-evaluated.

a. In today's worldwide marketing of particular aircraft types, it would seem prudent to first conduct a study aimed at locating the design critical icing environment by geographic location. Cober, et. al., (1995) discuss the Canadian Freezing Drizzle Experiment of 1995, with results that may define one of these geographic locations (the Canadian Maritimes).

b. Once this design critical location is identified (for example, is it the Great Lakes region? The Aleutian Islands? Northern Scandinavia? The Netherlands?) then a study of the icing conditions there might be conducted to redefine the environment based on an acceptable exceedance probability.

c. The exceedance probability that is in use today is 10 to the minus 3. This is quite a high probability, and it may be appropriate to re-examine it, particularly in light of the better understanding we have today of the effects of inflight icing on modern, high efficiency airfoil designs. If a graduated severity index were to be adopted, it would seem appropriate to identify the upper limit of those conditions considered as ambient by determining an exceedance probability for each graduation of the index, and then using as an upper limit that graduation which closest approximates a more acceptable exceedance probability of perhaps 10 to the minus 4 or even 10 to the minus 5.

Aircraft Catastrophic Failure Prevention

The Plan's areas of focus as regards the topic of catastrophic failure prevention are appropriate, in our view, with one exception. The recent fatal commuter accident of Atlantic Southeast Airlines' Flight 529 in Georgia, which was precipitated by the catastrophic failure of a propeller blade, as well as other similar fatal and non-fatal events, raises an important subject area that was omitted. This subject may be addressed under either turbine engine failures or structural failures in the Plan, or it could be the subject of a separate, new category (e.g. "Propeller Blade Failures").

The scope of this category would be similar to the scopes of the other topics in this area, and should include such issues of focus as failure mechanism determination, failure risk assessment, failure protection/containment methods, failure prevention methods and inspection methods and requirements.

Aircraft Navigation Technologies

ALPA policy calls for a precision approach capability to be available to any runways used by air carrier aircraft because precision approach procedures are inherently safer than non-precision approaches. Precision guidance has historically been provided by a ground-based Instrument Landing System (ILS), but combinations of ILS ground-site limitations and equally stringent lateral and vertical flight path obstacle clearance requirements have prevented ILS installations at many of the air carrier runways.

More recently, precision approaches have been successfully demonstrated using guidance information from the U.S. Global Positioning System (GPS) satellite constellation. Many of the limitations inherent to a ground-based system disappear when the reference is space-based. GPS guidance is especially compatible with the electronic flight management systems of modern, automated cockpits. When available through either Wide Area Augmentation Systems (WAAS), or Local Area Augmentation Systems (LAAS), airport capacities will be enhanced, regardless of weather conditions, because more of the airport's runways will be available for landings. It is imperative to continue aggressive research to allow technology to enhance airport capacities and aviation system safety.

The technologies of satellite navigation and electronic flight management systems also provide enhanced capability for improved situation awareness for flight crews through multi-functional cockpit displays. Certain applications of these technologies can also provide the capability for pilots to play a greater role in traffic separation through Automatic Dependent Surveillance (ADS). A display, or displays, providing combinations of aircraft position, traffic, weather, special use airspace, and other relevant navigation/communications data, could significantly improve the information suite currently available to flight crews, and improve their capabilities to move safely and efficiently in the National Airspace System (NAS). Variations of these capabilities have already been demonstrated, and many more are possible. Research on any of these related projects must continue in order to provide the necessary improvements to the NAS.

Aircraft Noise Reduction

ALPA believes that it is important to concentrate R&D efforts in the area of aircraft engine noise reduction as a primary method of making aircraft more compatible with communities surrounding airports, thereby enhancing capacity. There has been a great deal of progress in the reduction of engine noise in recent years. However, we expect that the American public will continue to demand further reductions in noise around airports. The best, and safest, way to reduce noise is to reduce it at the source - the engine.

Another way to minimize noise around airports is through the use of special piloting procedures. ALPA is opposed to the proliferation of certain procedures which have been implemented in the past in an effort to minimize the effects of noise. Some of these procedures that have been forced upon pilots have lessened the margins of safety.

ALPA supports, therefore, FAA's joint research efforts with NASA to further technological advances in engine noise reduction.

Airport Improvements, Miscellaneous

We fully support FAA's research program designed to reduce the number of runway incursions, a problem which continues to pose a significant safety hazard to commercial airline operations in spite of efforts to improve airport signs, lights and markings. Needed are better visual aids to guide pilots to and from active runways and airport terminals, especially in low visibility conditions.

ALPA fully supports the efforts of the FAA and others to develop a "soft-ground" arrestor bed designed to safely decelerate aircraft that have left the end of a runway during an overrun. The majority of aircraft accidents take place off the ends of runways and many of these are preventable if the surface beyond the runway is suitable for stopping an aircraft without incurring structural damage. The absence of available real estate at numerous runway ends for this purpose has driven the development of the soft-ground arrestor bed. FAA is currently utilizing "foamcrete" (which encapsulates air bubbles in concrete to create a very frangible material) in tests to determine the viability of this concept. We recommend that this project be fully funded and supported by congress to help reduce the potential for fatal accidents which occur off the ends of runways.

A fatal KC-135 crash in Alaska earlier this year due to bird strikes underscores the need for FAA research to focus on preventing wildlife hazards to commercial aviation. Although the KC-135 is a military aircraft, it could have just as easily been a commercial airliner resulting in the loss of hundreds of people. FAA research is needed to develop effective wildlife management techniques, including harassment and deterrent methodologies, to help enhance safety of all aircraft taking off and landing at commercial airports.

Airport Pavement Technology

The Plan details a project to perform R&D on airport pavement technology in order to reduce the annual outlay for future pavement maintenance. The federal government and aviation industry are together spending approximately $2 billion annually for pavement repairs and related expenses. The FAA's pavement research goal is to reduce costs of replacing pavements by 10 percent by the year 2010 which will be accomplished by addressing pavement design and evaluation, materials, construction methods, maintenance and repairs. This represents a $200 million annual cost savings on a single budget item.

Given the potential for such cost savings, it is imperative that the pavement research planned for implementation at the FAA Technical Center be fully funded this and future years until completion.

Aviation Security

The aviation industry was further persuaded this fall that the threat of terrorism as an ongoing, constant condition in the U.S. has either arrived or is very near arrival. Airports and airlines were place in a state of higher alert for a significant period of time and were required to implement advanced aviation security practices, some of which not only inconvenienced passengers, but were also expensive.

Correspondent to the increased threat, FAA has greatly accelerated its development of, and attention given to, aviation security-related R&D. This includes establishing a specification for explosive detection systems, which one company on the west coast is now manufacturing equipment to meet.

Further R&D is needed to develop equipment capable of rapidly processing passengers and their bags to preclude guns, knives, bombs and other weapons from being carried in the cabin or in cargo holds. Efforts should also focus on a system to profile passengers so as to expend the greatest amount of security-related resources to those passengers who may pose the greatest threat to the security of a flight.

We are encouraged by the progress being made on the development of a cargo container capable of withstanding the blast of an explosive device, as was reported in a recent Aviation Daily article. The challenge in this area will be designing such a device that will be cost effective and relatively light weight. Aircraft hardening is another area that the FAA should continue its research on to develop aircraft design features aimed at precluding a catastrophic explosion on future generations of commercial aircraft.

Aviation Weather Analysis and Forecasting

The FAA's Aviation Weather Analysis and Forecasting research project, aimed at enhancing the basic understanding of weather as it affects aviation, is a crucial step toward providing the capability for improved aviation-specific weather products. Weather is invariably a contributing factor in a majority of aviation accidents and incidents, often because of an inability to accurately detect or forecast weather conditions hazardous to flight. This project potentially increases capabilities to identify short term aviation-specific hazardous weather phenomena in the terminal area. It can also improve capabilities for accurate forecasts of icing, turbulence, thunderstorms and microbursts, all significant in the analyses of past accidents. An improvement of both current and forecast weather products could significantly enhance safety, and enable aviation weather users to make more effective strategic and tactical decisions for aviation operations.

Digital Automated Terminal Information System (ATIS)

A long-held safety concern about ATIS is pilots' inability to obtain it in a timely manner due to the problems inherent with its method of transmission, namely, through VHF voice. Often, due to frequency interference, pilots are not able to hear the ATIS broadcast until close to the airport and vital information required for the approach briefing is not received until the descent and approach are underway and the workload is high. Also, in many cases, the pilot who is trying to copy the information must remain off the ATC frequency for a long time, further decreasing margins of safety.

The FAA needs to speed up the acquisition process for digital ATIS equipment. This system, using ACARS, was successfully tested over two years ago and heartily endorsed by ALPA, but it has yet to be deployed in the field. The FAA should devote the resources to speed up the acquisition of the system so the benefit of increased safety of air carrier operations can be realized.

Funding For RTCA, Inc.

RTCA, Inc. is an organization funded by FAA and industry whose purpose is to produce aviation specifications needed to advance the state of the art in aeronautical electronic equipment. RTCA utilizes the donated time and energies of experts from the aviation industry, including the FAA, in the performance of this work.

A recent Aviation Daily article noted that the FAA will have to reduce its subsidy to RTCA, Inc., because of the reduction in the FAA Budget. The FAA usually contributes $75,000 annually to RTCA and this amount is budgeted to be halved. FAA should commit to full funding of RTCA because the operational and performance standards developed by this organization are paramount to the deployment of many FAA R&D programs (TCAS being but one example). Additionally, RTCA has sponsored task forces on GPS/GNSS and the philosophy of Free Flight, both of which defined the programs' operational concepts.

The RTCA process is, relatively speaking, an extremely inexpensive method of producing needed aviation specifications, many of which the FAA has neither the staffing nor the in-house expertise to produce. In fact, FAA attempted to produce certain aviation specifications several years ago and were unsuccessful for the reasons noted above. Funding RTCA must be considered a vital part of the acquisition activity in direct support of NAS operational requirements.

Human Factors

The FAA has developed what appears to be a comprehensive research plan for human factors issues in the National Airspace System (NAS). Continued human factors research is absolutely necessary to assure that pilots and controllers will be able to safely and efficiently operate new equipment and systems as they are developed and made operational.

The Plan details research needs in the area of human factors and aviation medicine. The research projects are designed to directly support the National Plan for Civil Aviation Human Factors. The research areas appear to be appropriate and needed.

We feel more can be done in integrating the research to address current and planned system implementations in the NAS. It is especially critical to conduct integrated research into the entire issue of Free Flight. This is an extremely important concept for air traffic control that is currently being developed and it will change most of the conventional concepts for flight operations in the NAS. There are many critical human factors issues which must be addressed regarding the conduct of these flight operations. These issues must be developed in an integrated manner to assure the highest possible levels of safety as Free Flight is being developed and implemented.

Reduced Separation Standards in Oceanic Airspace

The ALPA and IFALPA position regarding a reduction in separation standards proposed for oceanic airspace includes three key requirements: (1) ensure the establishment of aircraft navigation standards; (2) utilize direct pilot/controller communications or a pilot/controller data link capability that has been adequately tested during high density oceanic operations and found operationally acceptable; and, (3) provide oceanic controllers the displays and information necessary to properly handle operations unique to oceanic areas. This includes an effective conflict probe capability.

The first requirement, establishment of aircraft navigation standards, appears resolved because the navigation accuracy per Required Navigation Performance (RNP) 10 for certified aircraft will be required. However, communications and controller equipment need an urgent research and development effort.

Pilots often encounter severe convective weather activity that requires deviation from an ATC clearance on a routine basis. The current means of communications, HF radio, does not have a proven ability to support safe operations during convective weather in a reduced separation environment.

Our members have first-hand knowledge of the impact of convective weather in oceanic areas, especially in the South and Western Pacific areas. They routinely have to deviate from clearances in order to avoid flight through hazardous convective activity in this airspace. This is done even when a clearance from ATC has not been obtained due to the limitations of HF and delays in receiving permission from ATC. Possible conflicts with other aircraft operating at the same altitude on adjacent routes are mitigated to a significant extent by the existing 100-mile lateral separation standard. A reduced separation standard of 50 miles would clearly increase the risk during such events.

If a direct pilot/controller capability existed or a proven data link system were in place, and ATC had state-of-the-art displays and information processing equipment to replace the outdated flight data strip method of processing flight information, pilot deviations without clearances would not

generally be necessary. The use of a pre-planned deviation procedure used as a "last ditch" tool to avoid both convective weather and minimize conflicts would be the exception rather than the rule.

The FAA must devote the necessary resources to develop and acquire the much needed and, indeed, long overdue oceanic communications and ATC controller equipment.

Traffic Alert and Collision Avoidance System (TCAS)

An ongoing area of concern is TCAS, the Traffic Alert and Collision Avoidance System and its evolution to a higher level of sophistication and capability. TCAS II has been installed in virtually all passenger-carrying aircraft having more than 30 passenger seats. The Airport and Airway Safety and Capacity Expansion Act that required TCAS II also required FAA to develop and certify TCAS III, which would prompt the pilot to use horizontal and vertical collision avoidance maneuvers. Further, the Act required the FAA to ensure that TCAS II was upgradeable to TCAS III.

TCAS II is doing the job it was designed to do. The TCAS transition program data contains events in which potentially disastrous consequences were averted because of TCAS-directed maneuvers. Pilots have grown to depend on that system as a backup to ATC to avoid traffic conflicts in the terminal and en route areas.

From the onset of the TCAS Program, ALPA has consistently stated that the only TCAS system meeting our operational requirements is TCAS III. This is because it has the ability to direct horizontal and vertical avoidance advisories and thus take full advantage of aircraft operating characteristics and mirror what a pilot would probably do if he or she sighted an intruding aircraft. Our position on this issue has not changed and we endorsed TCAS II with its known operational limitations as an interim system only, pending the development and certification of TCAS III.

Although the TCAS III development program has been canceled, the need for an improved TCAS has not diminished. In fact, a new initiative within the aviation community has focused an even more pressing need for such a system, particularly its traffic display component. The new initiative we refer to, of course, is "Free Flight." This concept has received widespread endorsement by both the FAA and user community and will be the focal point of intense activity in the coming years. One of the key elements of this concept, if it is to reach the end state envisioned, is the ability of pilots to provide aircraft-to-aircraft separation. Since the Global Positioning System (GPS) has been introduced into the civil aviation community, the technology to provide both a collision avoidance system with horizontal escape capabilities and a traffic situation display with the accuracy and information needed to support Free Flight now exists. The Lincoln Laboratory is currently working on TCAS IV, which is a GPS-based system, and an RTCA special committee is in the process of developing the technical standards for a traffic situation display that is also GPS-based. ALPA strongly supports the continued development of both TCAS IV and an advanced traffic display of information that would provide pilots the situation awareness necessary to increase both the safety and efficiency of our national airspace

systems. The funding to complete these projects must be made available to the FAA for the specific purpose of continuing their development and certification.

Wake Vortices

More FAA research and development is needed in the area of wake vortices in order to increase margins of safety and enhance capacity through establishment of realistic in-trail separation standards. Some areas for research are: wake vortex detection, collection of meaningful wake vortex encounter data, definition of the hazard from the aspect of wake turbulence encounters and modification of ATC/pilot procedures to ensure that trailing aircraft are not inadvertently placed in the wake of a leading aircraft.

There are indications that an expanded use of winglets could help in reducing or controlling transport wake vortex hazards. More testing, as yet unfunded and unplanned, is required to confirm which winglet technologies serve this purpose and why. This research should also include the role that winglets play in not only reducing initial vortex strength, but what effect they may have on wake vortex decay as well.

In view of the need to increase system capacity and the change in fleet size and mix, it is appropriate to review aircraft classifications and separation standards. We have also learned that in addition to the dependence of wake vortices on wing span, weight, and span ratio, vortices are affected by various weather phenomena.

For all candidate capacity improvement concepts, the effectiveness of the algorithms and recommended procedures must be determined by means of validated vortex decay and vortex encounter hazard models which are based on vortex data, and encounter simulations. NASA's current work includes vortex-encounter modeling, vortex-hazard definition, sensor technology development and system concept work.

The Wake Vortex Program should parallel the successful joint FAA/NASA Wind Shear program, which was based on participation of the whole aviation community and a process of information exchange within the industry. The Wake Vortex program should utilize the efforts of FAA, NASA, the DOT's Volpe Transportation Center, MIT Lincoln Laboratory and industry. The major role of industry will be in the areas of training, data base analysis, design and implementation. In the near term, emphasis will be in the areas of education and training, instrumentation, field testing and data base development. Longer term participation should include prototype development for both semi-automatic and automatic systems, installation, and independent verification and validation procedures.

We appreciate the opportunity to submit comments to the Subcommittee.

OPENING STATEMENT

Mr. Chairman, I appreciate the invitation to testify today before the Senate Appropriations Subcommittee on Transportation. My name is Jack Fearnsides, and I am a Senior Vice President and General Manager of The MITRE Corporation. Perhaps more importantly for this hearing, I am the Director of the Center for Advanced Aviation System Development which is part of the MITRE Corporation and which is FAA's Federally Funded R&D Center or FFRDC. Our Center has a long history of contributions to the FAA. Our deep knowledge of technology, operations, and regulations enables our innovations to be oriented towards the actual fielding of new capabilities rather than just inventing new technologies. Some of our recent innovations include pre-departure clearance programs, a ghosting procedure that allows for a more efficient movement of multiple aircraft in the terminal area a process that allows simultaneous converging instrument approaches, a technology for monitoring the integrity of GPS signals, which will allow more complete use of satellite navigation, and technological and institutional innovations for the accelerated deployment of the Aeronautical Telecommunications Network.

My thesis today is that we are in the midst of three major paradigm shifts -- fundamental changes in the way we understand the science and technology of air traffic control. First the FAA, like so many federal agencies is dealing with a massive shift in our understanding about the system development process. Second, is a truly fundamental change in the way air traffic control must be conducted. Finally, we are witnessing a rather dramatic change in the way operating agencies such as the FAA must organize to manage that change. I'll discuss these three areas of change very briefly and conclude by showing how such change warrants a significant increase in FAA's RE&D funding for the next five years.

First to system development. The past ten years have seen massive changes in the way new technology is brought to market or field operations. The old system development paradigm began with what I like to call technology push, or supply-side technology. Government and government-sponsored researchers developed new technologies which led sequentially to the formulations of new operational and technological system requirements. These requirements led sequentially to specifications for an acquisition. (Since you've recently held hearings on the acquisition process, Mr. Chairman, and in the interest of brevity, I'll avoid that discussion.) Acquisition, of course,

leads sequentially to the various forms of test and evaluation and, often sequentially, to the formulation of procedures and training for the use of the new system. System requirements often were developed with only speculative understanding of their impact on system operations, so procedures and training had to wait until system delivery, to be established. All of this sequential processing takes time. We are learning how to do it in parallel.

One positive result of the supply-side approach to system development issue is that we now have an abundance of the technology that we used to think of when we thought of government-sponsored R&D. We need to learn how to use this technology to do air traffic control differently; how to leverage the capital investments made in the National Airspace System. This new knowledge is procedural and operational as well as technological. Moreover, as I'll show below, we now have a critical demand for this new knowledge. So here is another change in thinking. Let's think of the FAA's RE&D program as investment in knowledge as well as investments in technology. And let's understand that it is now a demand pull more than a technology push program. Also, and very importantly, the challenge now is as much to integrate extensive commercial technological development as to develop government R&D.

But the new concept of R&D is only the beginning of the massive shift in the system development process. As mentioned above, we know now how to do more of the development steps in parallel rather than sequentially and how to continuously evolve the capability of a system in a sequence of short development cycles rather than attempt massive improvements every 10-20 years. We can afford and we know how to use simulations and prototypes to develop requirements in a way that not only enables visualization of the effects of these requirements but also enables parallel development test and evaluation, parallel procedures development, and parallel training requirements formulation. And for the kind of R&D I'll be discussing today, which is mostly the transfer of developed knowledge into software, the use of concurrent engineering can effect very large reductions in development time as can the understanding of how to integrate available commercial technology in an open system architecture rather than doing custom software development.

The second change I'd like to discuss today is the shift from Air Traffic Control (ATC) to air traffic management (ATM). The ATM concept encompasses the traditional ATC tactical separation assurance role as well as the newer strategic element of traffic flow management (TFM) in order to

try to maximize the capacity of the NAS, while improving safety. (Safety margins must be improved if only to have the same safety performance levels with increased traffic.) As I will discuss below, we know practically nothing about how to do TFM. This is the first part of the demand pull for new knowledge that will support the investments I list below.

In my opinion, addition of a strategic dimension to ATC is the most fundamental change in how ATC needs to be done since the introduction of radar services. But there is also the need to understand the technological, operational and procedural implications of emerging ATC (& eventually TFM) functional capabilities such as Automated En-Route ATC or AERA, Terminal ATC Automation or TATCA, data-link, automatic dependent surveillance, and GPS. In this regard, I would like to give special attention to the rapidly developing capabilities in the cockpit. We need to know how these technologies integrate with ATM systems to achieve maximum operational gains for NAS users and operators. We also need to know the implications of the introduction of these new capabilities on the roles of the controllers, pilots, and maintenance personnel. Finally, and maybe most importantly, we need to know how to transition from existing to new systems.

The final paradigm shift I'd like to discuss is the revolution in American management that is well underway in U.S. industry and is being introduced in government in general and the FAA in particular. I am sure that the subcommittee has heard of Joe Del Balzo's Operations Planning and Management Team which is designed to bring operational, regulatory, and system development organizations together to solve the complex technical, operational and regulatory problems that the FAA Administrator must deal with. A similar construct was used by Marty Pozesky to begin thinking about how to develop the knowledge, data, and tools to develop a traffic flow management or TFM capability. To accomplish this, a group called the Traffic Flow Management Architecture and Requirements Team (or TFM-ART) was formed. It is composed of senior operational and technical leaders. They have put together a plan that serves as the framework for one part of the R&D increment I'll propose below.

1. Traffic Flow Management R&D

Mr. Chairman, members of the Subcommittee, in preparing for this testimony I spent some time trying to compose a visualization of the complex problem that needs to be solved. It is

so difficult that until recently, researchers dealt with improvements in only part of the system. But as we will see, this can only produce a suboptimization of the system.

There are roughly five thousand aircraft flying over the Continental U.S. at any one time. Each of these aircraft has a flight plan from its origin to destination. And because of the need for separation standards, each aircraft's motion influences the motion of adjacent aircraft almost as if they were connected by giant springs. Thus, a decision to move one aircraft has an effect on other aircraft.

Now if there were no flight time uncertainties or queuing or weather, one could imagine a super brain developing a scheme to get these aircraft from origin to destination in minimum time, or using minimum fuel, or at some measure of least cost to the aircraft owner. But all of these complications (and more) factors exist. The good news is that there are many decision makers to assure separation and to try to expedite flows. The other news is that because of the system dynamics mentioned above, these decisions have to be coordinated. The decision makers are en-route, terminal, tower, and flow controllers, pilots and airline dispatchers. Now let's restate the ATM problem in one of its forms. Suppose weather limits the capacity of an airport with multiple hub operations. What actions should ATC, dispatchers, and pilots take to minimize the description?

The problem solver needs to know the following information:

1. How should each aircraft be moved? (We call this strategy formulation research.)

2. What is the net result of simultaneous actions on multiple aircraft? (We call this system dynamics research.)

3. How should controllers, dispatchers, and pilots coordinate their proposed actions? (We call this collaboration research because it is likely to be aided and abetted by newly emerging collaborative computing technologies.)

4. What tool or aids do we need to provide controllers, dispatchers, and pilots to recognize problems within their domain? (Decision Support R&D)

5. How does one even calculate whether one set of strategies is as effective as another set? How do we reconcile the different performance measures of the controllers and dispatchers? (Performance Analysis)

6. What kind and how much data should each decision maker have and, given that this is likely to be a lot of data, how should this data be managed? (Data management research)

In order to expedite the fielding of a traffic flow management capability (which is high on the agenda of system users, we must proceed to research each of these six areas in parallel.

We estimate the cost of this investment to be $150M over 5 years, beginning in FY94. We cannot estimate the benefits without developing a simulation of the system itself. It is too complex because we need to know more about the six areas mentioned above. A plan for attaining this knowledge is being developed. As with all modern developments, there can be parallel activities in the six areas and by various participants. Most importantly in this regard, note that even the research can't be done just by the government. There must be a mechanism for the system users to bring their knowledge to the table and to agree on the pace of knowledge gaining and implementation. This means that the management of this initiative must not be hierarchical, but heterarchical, horizontal instead of vertical.

The new Air Traffic Management (ATM=ATC + TFM) paradigm is in sight. Through its TFM-ART mechanism, the FAA and the airlines/users have agreed on a joint management approach. Note that the plan not only agrees on what needs to be done but also how to do it using the new system development paradigm. This budding enterprise now needs only some venture capital.

2. System Integration R&D

Let me say first what I mean by the system. It is all of the aircraft, the pilots, dispatchers, controllers, and all of the connections between them and their sources of information. What we described above is the knowledge needed to develop the fundamentally new TFM or capacity management capability. Even though this involves coordination with system users, it is in the context of everything else that is going on, essentially, a vertical or singular development.

This subcommittee is well aware of other ATC automation investments that have been and are being made: AERA (which provides the decision support for en-route controllers to further enable money-saving user-preferred routes and to handle more aircraft thus avoiding sector saturation); TATCA (which provides similar decision support capability for terminal controllers), the myriad of data link applications, satellites, alternate dependent surveillance, and very importantly, increased decision-making capability in the cockpit. We know pretty well how each of these systems works by itself (For example, the interaction of the en-route controller with the AERA capability has been developed interactively with a controller team over the last 10 years). What we don't know is how these so-called functional capabilities work together and what the role of the controller will be when they are actually in place. Will the current definition of en-route and terminal sectors remain the same? How do the following pairs of capabilities integrate?

1. AERA with the Descent Advisor Function of TATCA?

2. AERA with the TMA function of TATCA (and eventually with the TFM system described above)?

3. AERA with Data Link?

4. TATCA with TFM?

5. TATCA with Data Link?

6. The cockpit with AERA?

7. The cockpit with TATCA?

8. The cockpit with Data Link?

9. Oceanic ATC with AERA?

10. Oceanic ATC with Data Link?

The need to integrate all of this software is obvious. But how? And how will the controllers interact with these various combinations? What new procedures are required? What training? And how will we transition to these new capabilities? In the old system development paradigm, these questions would have been answered in sequence, after production. But there is a demand to accelerate these user benefits and the answers and questions must be accelerated as well.

Obviously, there is a lot of engineering to be done but this is not going to be accomplished merely by classical configuration control or interface document control procedures. We must experiment and learn. And we must experiment and learn together: users, operators, engineers, computer scientists, human factors specialists, etc. Once again, we will need to utilize a less vertical and more horizontal management approach.

A plan is being developed that outlines what needs to be done, how the doing can be accelerated by using modern system development techniques, and how it could be managed. We do not want the synergistic benefits of our parallel developments to be delayed because we waited until each was developed to begin to worry about its integration with the system that exists at that time, or because we didn't understand that function B should have preceded function A in transition or because we didn't anticipate the need for new operational or what training was required. This knowledge cannot be inferred logically; it must be developed experimentally. We estimate the cost of this automation integration program to be about $110M over five years. It should begin in FY94.

Mr. Chairman, Members of Senate Committee, these combined investments total roughly 20% of the current annual RE&D budget. You have heard from Norm Augustine that the current budget should be doubled. What we have described here is only a part (20%) of that increment.

Norm's request for extra money comes from other technological opportunities, many of which are more aeronautical than ATC (or as we should call it, ATM). These are also important benefits for the nation and our critical bases aviation-related industries. The request here is not to forget the basic mission of the FAA, the need to modernize the functionality or utility of the system as well as the equipment, and the needs of the users of the National Airspace System.

Committee on Science
Subcommittee on Technology
U.S. House of Representatives

An Industry Perspective of FAA Research and Development Programs

Thursday, December 7, 1995

Statement of Robert Spitzer
Vice President of Engineering
Boeing Commercial Airplane Group
The Boeing Company

Air transportation is the preeminent means for commerce and communication among people. The overall impact on the U.S. economy is enormous, accounting for approximately 10% of U.S. GDP. This success is the result of an industry-government partnership, a triad of the airlines, the FAA, and the manufacturers.

The airlines establish operational concepts consistent with where the travelers and cargo want to go (destinations), when they want to go (schedules), and what they want to pay (fares and rates). The FAA establishes safety criteria and operating rules, ensures compliance, and provides the air traffic service. The manufacturers design and build the aircraft that have the capabilities needed to satisfy both the airlines' and FAA's requirements. The common objective that links all three is safety.

Industry-government triad efforts have created a national air transportation system second to none. It has an exceptionally good safety record and on-time arrival rate. In spite of rising cost pressures, the system has provided air transportation at increasingly affordable prices.

With these successes it would be easy to believe that we can rest on our laurels. This is not true. We cannot rest. Current demands are placing ever-increasing strains on the air transportation system. Flight times between cities are becoming longer. Delays and congestion are the two common factors limiting the airlines abilities to maximize the utilization of their aircraft fleets. New potential solutions require more coordination among the members of the triad. Future growth will compound the problem.

Passenger growth, forecast at 5% per year, will see the number of passengers triple worldwide by 2014, and will result in more strain on the system. The airlines will need to operate more aircraft and get more utilization from each one every day. The number of commercial aircraft is envisioned to double from 10,600 today, to over 20,600 by 2014. The average commercial aircraft will grow in size from 193 seats in 1994, to 223 seats in 2014, making each flight's as-scheduled operation that much more important.

In order to address the essential mission of providing a viable air transportation system for aircraft operating to and from the U.S., as well as within the U.S., the FAA has undertaken a number of innovative initiatives including:

- Commitment to an air traffic services plan based on airline needs to achieve greater economies by more fully utilizing existing aircraft capabilities.

- Establishment of a consensus to work with all elements of the industry to seek continuous improvements in safety.

- Commitment to implement a global position satellite based communications, navigation and surveillance system, for both wide area and local area augmentation situations.

- Establishment of a national task force to provide recommendations for implementing the GPS based system and a new operating concept titled "Free Flight". Free Flight is a concept in which the user determines the path and speed of the airplane in real time and the service provider (the FAA) assures separation of aircraft in flight.

- Establishment of a memorandum of understanding with NASA to leverage research being conducted to make aircraft operate more efficiently in the U.S. air transportation system. Notable are the NASA Terminal Area Productivity (TAP) and Advanced Air Traffic Technology (AATT) programs.

- Establishment of a designated Aviation Weather Division to expedite implementation and coordination of aviation weather services and systems. This will provide a focus for the delivery and development of weather information products of both government and private industry. Weather has a marked effect on both safety and operational efficiency.

While these new initiatives address the issues of capacity, efficiency and affordability, a new aeronautics partnership is needed to ensure a proper balance is maintained among safety, efficiency and affordability. A partnership which emphasizes an air transportation system approach and involves industry is needed to maximize the limited resources available to each of the stakeholders, including the FAA.

The RTCA Task Force III Report (Free Flight Implementation) provided to the FAA Administrator, includes a recommendation to form such a government/industry partnership. The objectives of the partnership would be:

- To establish an agreed-to implementation strategy and milestones.

- To periodically review government and industry progress in meeting implementation commitments via the use of appropriate metrics.
- To identify new Free Flight implementation opportunities as well as events/situations that are inhibiting progress, and review actions that are taken.

We believe this government/industry steering committee (partnership) will define the most effective advances for the air transportation system to maximize all stakeholders opportunities for success.

In conclusion, the civil aviation community stands at the threshold of a great opportunity to safely re-order the air traffic system. In order to seize this opportunity, FAA research and development activities must be conducted in accordance with aviation community needs and in concert with other on-going research and development efforts, including those being conducted by industry and other government agencies. The FAA should be supported in its efforts to modernize the air transportation system.

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NWS Response to Question Asked of Alan Thomas, OAR
at the Science Committee Hearing

December 7, 1995

Question: Within the past month the National Academy of Sciences has released a report which calls on FAA to assume a stronger role in providing aviation weather services. The thrust of the report is that there has been a lack of leadership in setting priorities for and establishing the programs needed to improve weather services for aviation users. Relative to aviation weather research, the report finds inadequate integration among research programs and inadequate integration with operational programs. The report also notes that a 1977 agreement between FAA and NOAA on development of aviation weather requirements and needed systems has never been carried out in practice, nor has the high-level interagency coordination included in the agreement been put in place.

a) Do you agree with the NAS report that NOAA and FAA should carry out the intent of the 1977 agreement to establish requirements and to coordinate more closely on aviation weather related R&D?

b) Do you agree with the NAS report recommendation that FAA should take a stronger lead in focusing federal R&D efforts on aviation weather services?

Answer: NOAA/NWS agrees wholeheartedly that FAA, in conjunction with NOAA/NWS, should establish aviation weather requirements and that both agencies should coordinate on the development of a comprehensive aviation weather research and development plan, and a modernized service plan. NOAA/NWS also agrees that it is appropriate for FAA to assume a strong lead in focusing this effort. The 1977 agreement, while still technically in effect, probably needs to be revisited and updated.

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